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CONTENTS

DEPARTMENTS

For complete table of contents see advertising page V

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Once again as the holiday season draws near, we extend our best wishes and express our appreciation for the pleasant association we have had with our many friends.

May the New Year bring Victory and lasting peace to all people who cherish the right to live in a world of freedom and equality.

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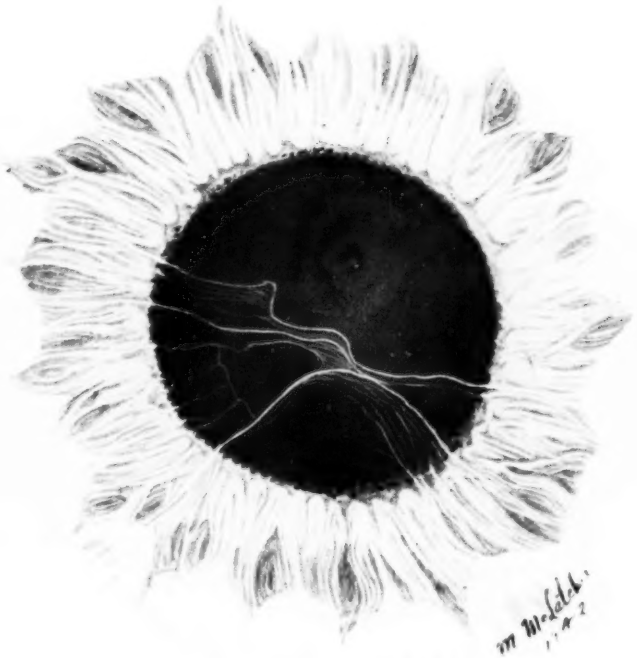

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AMERICAN JOURNAL OF OPHTHALMOLOGY

VOLUME 25 DECEMBER, 1942 NUMBER 12

FIBROBLASTIC OVERGROWTH OF PERSISTENT TUNICA VASCULOSA LENTIS IN INFANTS BORN PREMATURELY*

III. STUDIES IN DEVELOPMENT AND REGRESSION OF HYALOID ARTERY AND TUNICA VASCULOSA LENTIS

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Boston

An intensive study is being made of conditions allied to persistent tunica vasculosa lentis particularly in infants born prematurely.[1, 2] Many of these conditions, hitherto unassociated, may be considered as one disease entity for which the term fibroplasia has been suggested.[2] This entity consists in primary and secondary changes related to: (1) persistence of all or part of the hyaloid-artery system; (2) growth of embryonic connective tissue behind the lens; (3) persistence or overgrowth of fibrillar structure of vitreous. These changes appear to arise from hypertrophy and perhaps even sclerosis of the persistent hyaloid artery and tunica vasculosa lentis.†

Part of this study has been an attempt to follow in detail the development and regression of the hyaloid-artery system. The frequency of conflicting statements found in a review of the literature led to a laboratory investigation of the problem.[3-9] Some of the controversial points as well as some interesting new observations are discussed.

The material used consisted in serial sections of eyes from human fetuses representing many stages of development. More than 50 fetuses were included in

* From the Massachusetts Eye and Ear Infirmary. Read before the Association for Research in Ophthalmology, thirteenth scientific meeting, at Atlantic City, June 9, 1942.

This study has been made possible through a special gift to the Massachusetts Eye and Ear Infirmary. The following, through their help and interest, have contributed greatly to the work accomplished: Dr. G. L. Streeter and Dr. G. W. Corner of the Carnegie Institute; Dr. E. J. Farris of the Wistar Institute; Drs. S. B. Wolbach, G. B. Wislocki, Shields Warren, Tracy Mallory, A. H. Hertig, Myrtle Canavan, S. H. Clifford, and Charles Jennings of Harvard; and Dr. L. S. Stone of Yale. Much of the technical work on the animal experimentation and the preparation of specimens has been done by Dr. Bertha Offenbach and the research assistants.

† This will be discussed further in a later publication.

Plate 7. (Terry). A, translucent strands of membrane remaining in the eye of a man aged 20 years. These strands can be followed to collarette of iris where they are attached to superficial mesodermal layer of iris. Inquiry revealed this patient had been born three weeks prematurely. B, in three-day-old infant born six weeks prematurely. Vessels are seen only with a convex lens of 10D. or more when one is within focal distance. The red color of the vessels in the iris is also plainly visible. These are seen well with the Wood McNair hand slitlamp. C, same infant at four and one-half months of age. Note disappearance of membrane and change in color of iris with differentiation. D, in infant, aged 4 days, born 12 weeks prematurely. Note vessels are more numerous, extend nearer to center of pupil, and make up finer mesh. This infant showed changes similar to those noted in C at four and one-half months of age.

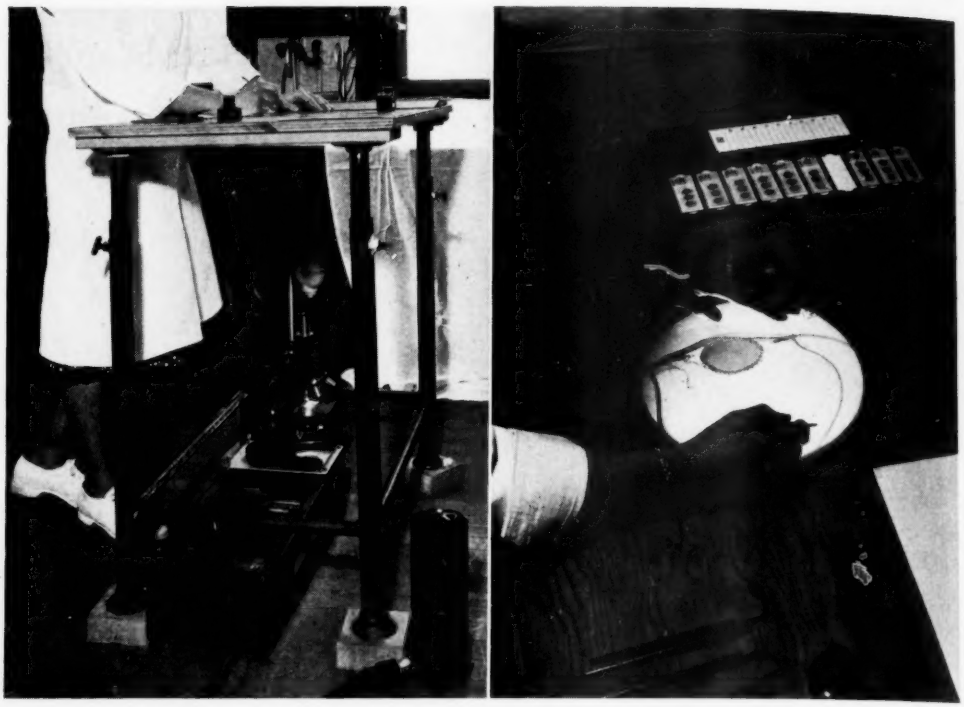

Fig. 1 (Terry). A, slide on microprojector under table with adjustable legs. B, top view of table showing section projected upon ground glass. Artist is tracing vessels on sheet of cellulose acetate.

this series.* Fetal and newborn animals were also studied, including eyes from cats, rats, pigs, and opossums. A number of infants born prematurely were examined periodically to determine the rate at which the pupillary membrane and hyaloid artery normally disappear.

The human material obtained in a relatively fresh state and much of the animal material was prepared by injections of dilute India ink into the vascular system. Usually these injections were made into the exposed heart but some were made intracardially without exposure of the heart. Others were made into the carotid artery, and in the human fetuses the best injections were made through the umbilical vein. Satisfactory injections were made as long as 12 hours after visceral death if the specimens had been properly refrigerated. Apparently any blood clots that formed were small and perhaps contracted, as otherwise satisfactory injections should not have been obtained.

Much of the human material first obtained was sectioned at 10 to 20 microns.

* Many of these specimens were from a collection made during the last three years by Dr. Julian F. Chisholm, Jr.

Fig. 2 (Terry). Stereophotographs of reconstructions of the hyaloid artery and tunica vasculosa lentis. A (photograph made at Carnegie Institute of Embryology), 22-mm. human embryo eye, ×120. The vessels appear much larger proportionately than in other reconstructions where magnification was from 20 to 30. Note widespread vascularization of vitreous, also size of lens in proportion to eye. B, 24-week human fetus, ×30. Note lack of vessels in vitreous, striking parallelism of "intermediary" vessels, and small size of lens in proportion to eye. C, cat one day of age, ×25. Note straight unbranching hyaloid and great regularity of vessels.


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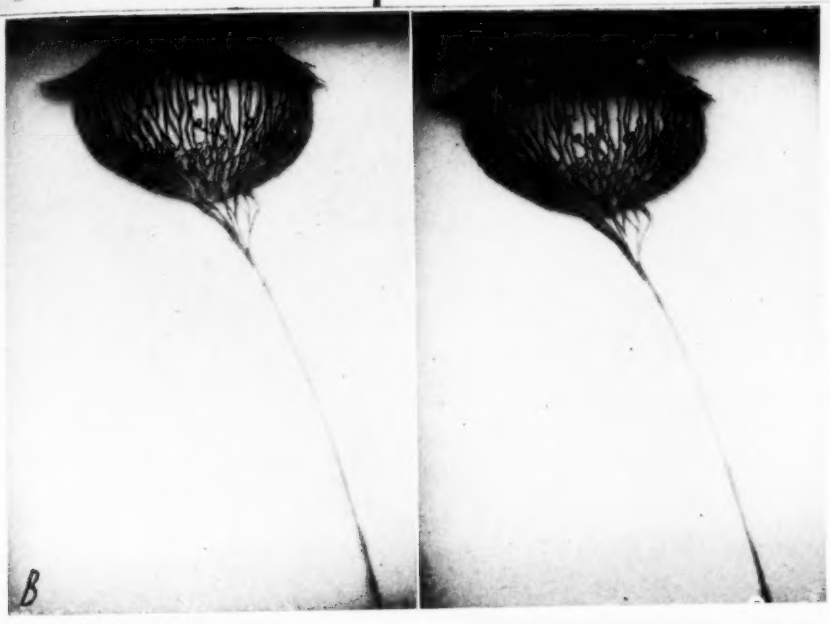
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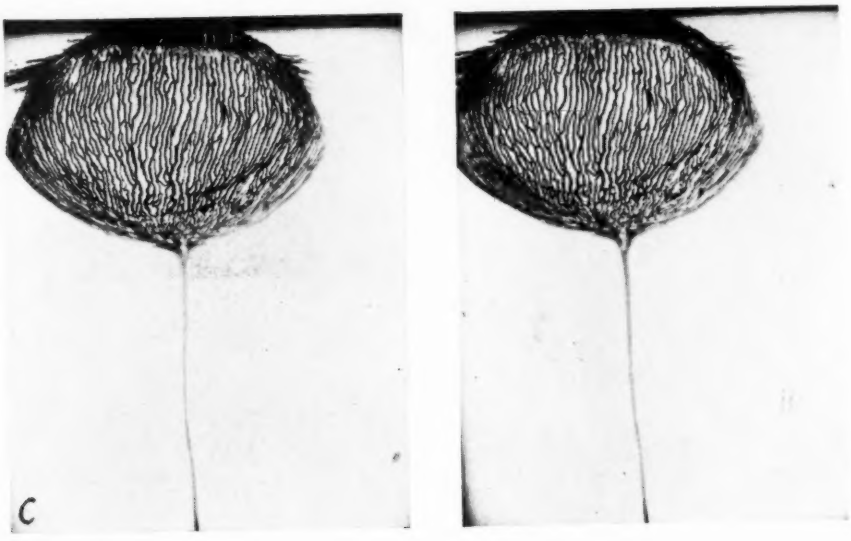
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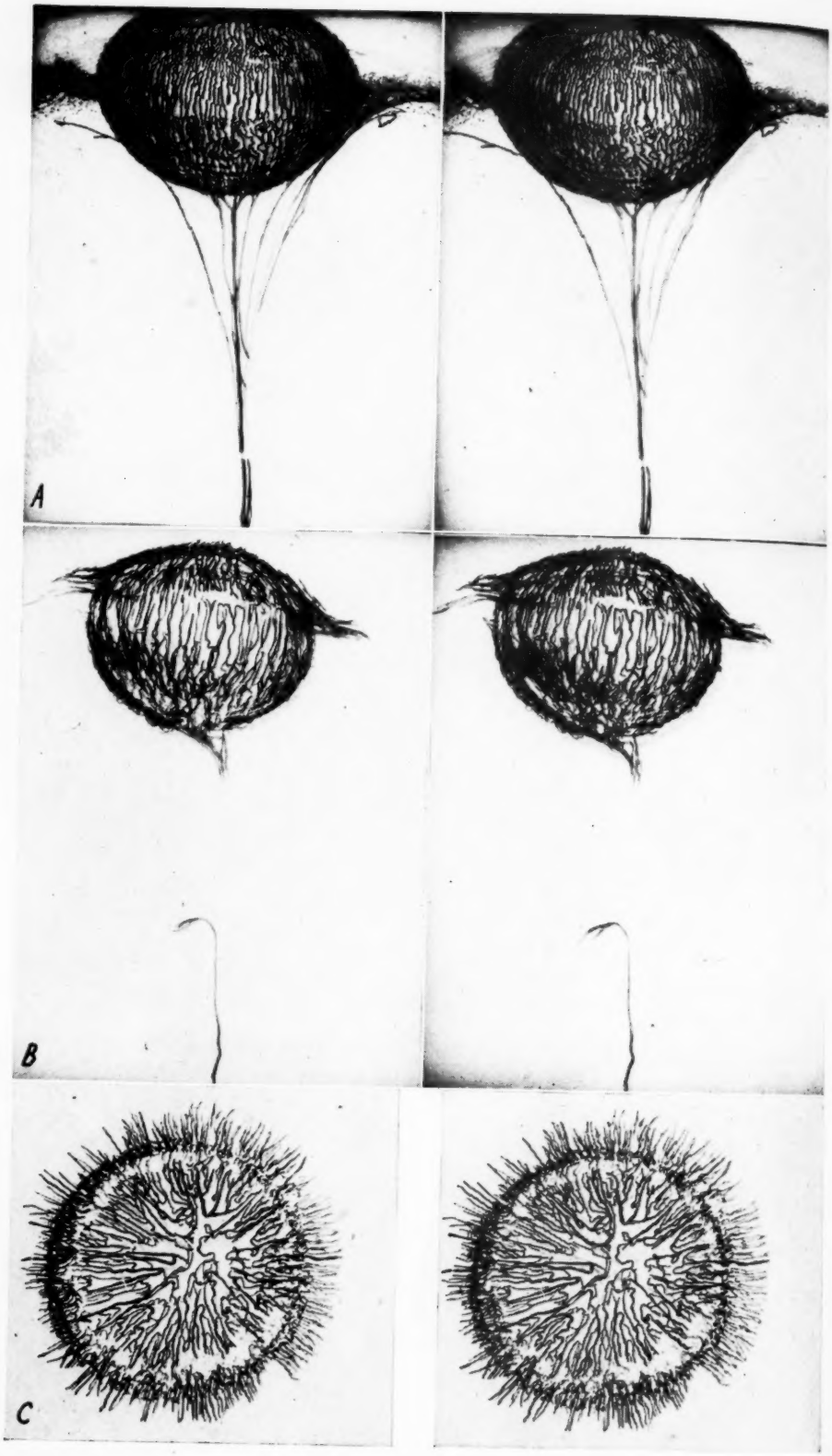
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Although this made study of the cellular arrangement easy, it was difficult to follow the vessel pattern. The later material, particularly that which had been injected, was sectioned at 50 to 100 microns. These sections showed the injected vessels clearly, and three-dimensional reconstructions were made which graphically portrayed the system at the stage selected. Serial sections were projected by microscope onto a ground-glass plate. (fig. 1 A and B). The vessels were traced on sheets of cellulose acetate, each sheet being carefully aligned with the previous sheet. The combined sheets, separated by mats for proper depth,* gave an exact model of the hyaloid artery and tunica vasculosa lentis (figs. 2 and 3). These models can be placed in illuminated racks for study and comparison of the different stages. In figure 3A the iris and ciliary body were also drawn to depict the relation of the tunica vasculosa lentis with these organs.

In an attempt to determine the arterial and venous connection of the system, and to verify the direction of the blood flow, differential injections[10] were made. Gelatin and rice starch colored with carmine and Berlin blue were injected. Neither the gelatin nor the rice starch could pass through the capillaries. In addition, injections were made after dissection to expose the vitreous so that the flow could be observed directly. Care was taken to insert the injecting needle through the heart into the aorta past the ductus arteriosus so that the injection would be only arterial. To insure this a clamp was placed across both the aorta and the intra-aortal needle at the level of the ductus arteriosus.

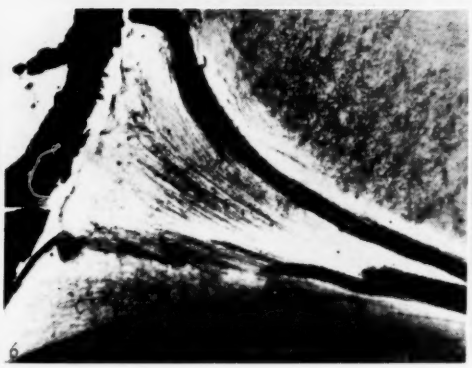
The first evidence of an ocular vascular system is perhaps at the 4½-mm. stage† with the appearance of two sets of blood vessels in the region of the fetal fissure.[6] One, the hyaloid artery, enters the optic cup to supply the interior of the eye while the other, the annular vessel, fans out around the margin of the cup to supply the anterior segment. As these two sets of vessels develop they anastomose freely. In early fetal life the direction of blood flow is not constant, for there is no real distinction between artery and vein, the direction being determined by variable pressure differences,[6] thus at times a flow from the annular vessel toward the hyaloid artery may be present. After the direction has been finally established, the flow was invariably from the hyaloid artery toward the lens in all fetuses in which direct observations were made. Some flow from the iris into the pupillary membrane proved that this membrane does have an arterial supply of its own as Versari[7] has stated.

Soon after the appearance of the hyaloid artery itself, a peripheral system develops through the vitreous called the vasa hyaloidea propria. This gains con-

*The necessary distance between tracings was determined by the following formula: $D = MT$, where M is magnification and T, the thickness at which the section was cut.

†All measurements refer to humans unless otherwise specified.

Fig. 3 (Terry). Stereophotographs of reconstructions of hyaloid artery and tunica vasculosa lentis. A, 22-cm. pig, ×35. Iris and ciliary body were drawn in light colors which did not photograph well. Vasa hyaloidea propria are closer to main hyaloid trunk than they are in life because of vitreous shrinkage. Three terminal branches of main hyaloid are well seen a short distance behind lens. B, 130-mm. human fetus, ×24. Spontaneous rupture of hyaloid artery during fixation with central end hooked backwardly. Note region in which "intermediary" portion and pupillary membrane drain. C, other eye of B, sectioned equatorially. Anterior view showing vessels of pupillary membrane. Vessels are beginning to disappear centrally in what will be pupillary area. Peripherally vessels cannot be followed accurately after entering iris stroma, thus giving irregular length to iris vessels.



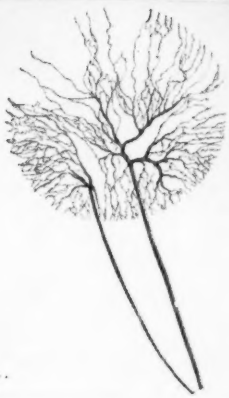


Fig. 4 (Terry). Section through the margin of the optic cup of a 93-mm. human fetus. Terminal branches of the vasa hyaloidea propria anastomosing with vessels of "intermediary" portion.

Fig. 5 (Terry). Section through center of eye of 22-mm. human embryo. Same eye used in reconstruction (fig. 2 A). Many of the apparent capillary buds in the reconstruction proved to be vessels cut tangentially so that the lumen was in another section. At no place do the peripheral branches actually enter the retina.

Fig. 6 (Terry). Section just posterior to the lens of a 205-mm. human fetus showing fibrillar vitreous. Note difference in character of fibrils in primary vitreous near hyaloid vessels from that of secondary vitreous which has much less blood supply.

Fig. 7 (Terry). Artist's drawing of double hyaloid artery in fetal pig's eye. Details of branching vessels were omitted.

nection with the tunica vasculosa lentis in the region of the equator of the developing lens vesicle (fig. 4). This complex, anastomosing system permeates all portions of the early vitreous humor (fig. 5). In stained sections viewed under the ordinary microscope the fetal vitreous appears fibrillar. Because the vitreous maintains this fibrillar structure only while blood vessels are present, it can be postulated that there is a relationship between fibrillar vitreous and presence of blood vessels (fig. 6). It must be remembered, however, that the fibrillar vitreous is transparent as seen grossly or under the dissecting microscope, either in a fresh state or after formalin fixation. This then, rules out an earlier conception[1] that the retrolental mass of opaque tissue seen in the prematurely born infants[2] could represent a persistence of the primary vitreous.

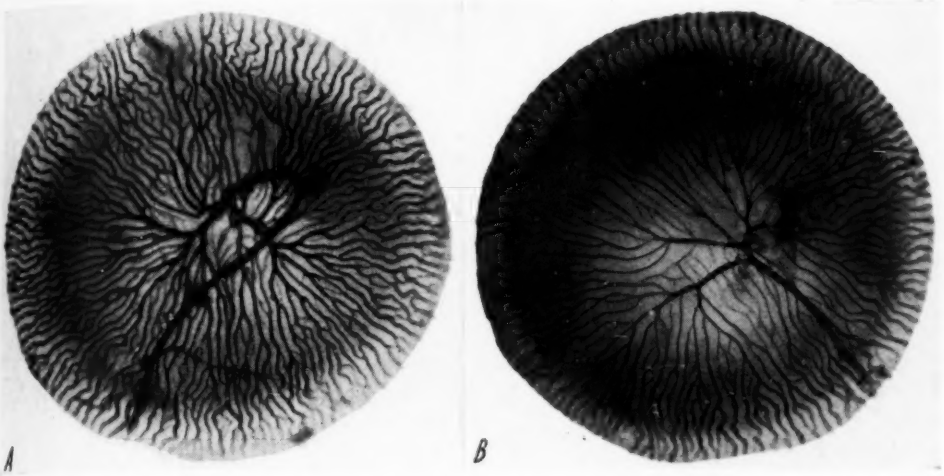


Fig. 8 (Terry). Posterior surface of lens from fetal pig's eye. Course of main hyaloid artery was distorted when lens-vitreous preparation was dissected from the globe. A, 15-cm. pig. Note large caliber and wide distribution of vessels, also numerous anastomoses. B, 20-cm. pig. Thinning and straightening of vessels, also lessening of anastomoses. Note three terminal branches of main hyaloid artery. In those eyes on which Y suture of lens could be seen, correspondence to the three branches was noted, although the center of branching never corresponded to center of Y suture.

There is certain variance observed in the hyaloid system of various species. For instance, I have not observed a vasa hyaloidea propria in the opossum.* In the rat, the branches of the hyaloidea propria arise more proximally than in the cat, pig, or human. In the cat the symmetry of the hyaloid system is most marked (fig. 2 C). Of all the species studied, the hyaloid system in the pig resembles most closely that found in man (fig. 3 A). It is most probable, of course, that the vasa hyaloidea propria is of no importance in consideration of retrolental fibroplasia because it has already disappeared at the stage when the iris is beginning to form and this is long before retrolental fibroplasia develops.

The tunica vasculosa lentis is first recognized as the terminal branching of the main hyaloid trunk. It is interesting to note that the hyaloid artery is not invariably a single vessel. In one pig fetus it was made up of two vessels, both a branch from a common trunk in the region of the optic nerve (fig. 7). It was also interesting to note that the other eye of this same pig had the classical single hyaloid, and the litter mates examined after gross dissection also showed only one hyaloid artery in each eye.

Early, the hyaloid artery appears to end in the neighborhood of the posterior part of the lens plate.[6] As the main trunk of the hyaloid approaches the lens, it tends to divide into three main branches (figs. 8 B and 3 A). These branches conform roughly to the pattern of the Y figure on the posterior portion of the lens.†

The group of vessels forming the tunica vasculosa lentis, by the 20-mm. stage, can be identified as three separate sets according to position: the posterior or capsullary, the lateral or capsulo-pupillary, and the anterior which is the pupillary

* From a study of Wistar Institute sections, preparations of Dr. L. S. Stone of Yale, and my own slides.

† This correlation was first noted by Dr. Donald Howard when he viewed certain of the specimens under the dissecting microscope.

membrane itself. It must be stressed that the tunica vasculosa lentis, at this stage and every other stage, consists only of a network of vessels devoid of any embryonic connective tissue in the interstices. A retrolental overgrowth of embryonic connective tissue involving the persistent tunica vasculosa lentis is the pathologic condition under consideration, for which the term retrolental fibroplasia has been suggested.[2]

The posterior portion of the tunica vasculosa lentis is formed by capillary buds from the hyaloid artery spreading out over the posterior surface of the lens. These buds spread rapidly until the whole back of the lens is covered by a vascular net. This net is made up of many vessels, rich in anastomoses (fig. 8 A). Later in fetal life the net becomes stretched, the vessels straightened and of smaller caliber, and fewer anastomoses are evident[7] (fig. 8 B).

That portion of the tunica vasculosa lentis intermediary between the posterior portion and the pupillary membrane is commonly called the lateral or capsulopupillary. As these terms are perhaps confusing, in this communication the term "intermediary" will be used instead. Early, the "intermediary" portion is short, running from the equator of the lens only to the margin of the optic cup where anastomosis with the annular vessel occurs (fig. 9).

Soon these vessels increase in number, eventually forming palisadelike vessels that drain the tunica vasculosa lentis, after disappearance of the annular vessel, into the choriocapillaris in the ciliary zone and later into iris veins. These "intermediary" vessels always appear in parallel formation with very few anastomoses. They are present only in the ciliary valleys, and it is interesting to speculate on the reason for this parallel, ever-simple vessel pattern in the region of the equator of the lens (fig. 10). These studies have indicated a direct relation between the formation of ciliary processes and the arrangement of the "intermediary" vessels of the tunica vasculosa lentis (fig. 11). No attempt has been made to determine which first, since this study is concerned with later stages. However, it is reasonable to believe that the ciliary proc-

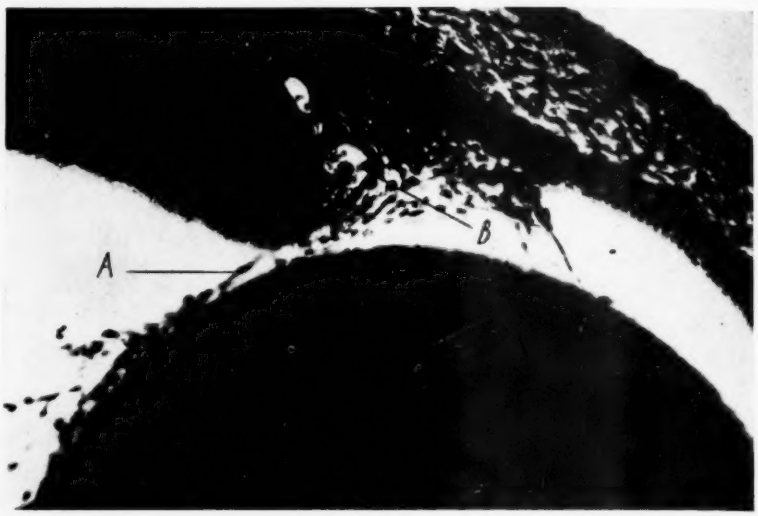


Fig. 9 (Terry). Section through margin of optic cup of 22-mm. human embryo. "Intermediary" vessel, A, anastomosing with annular vessel, B.

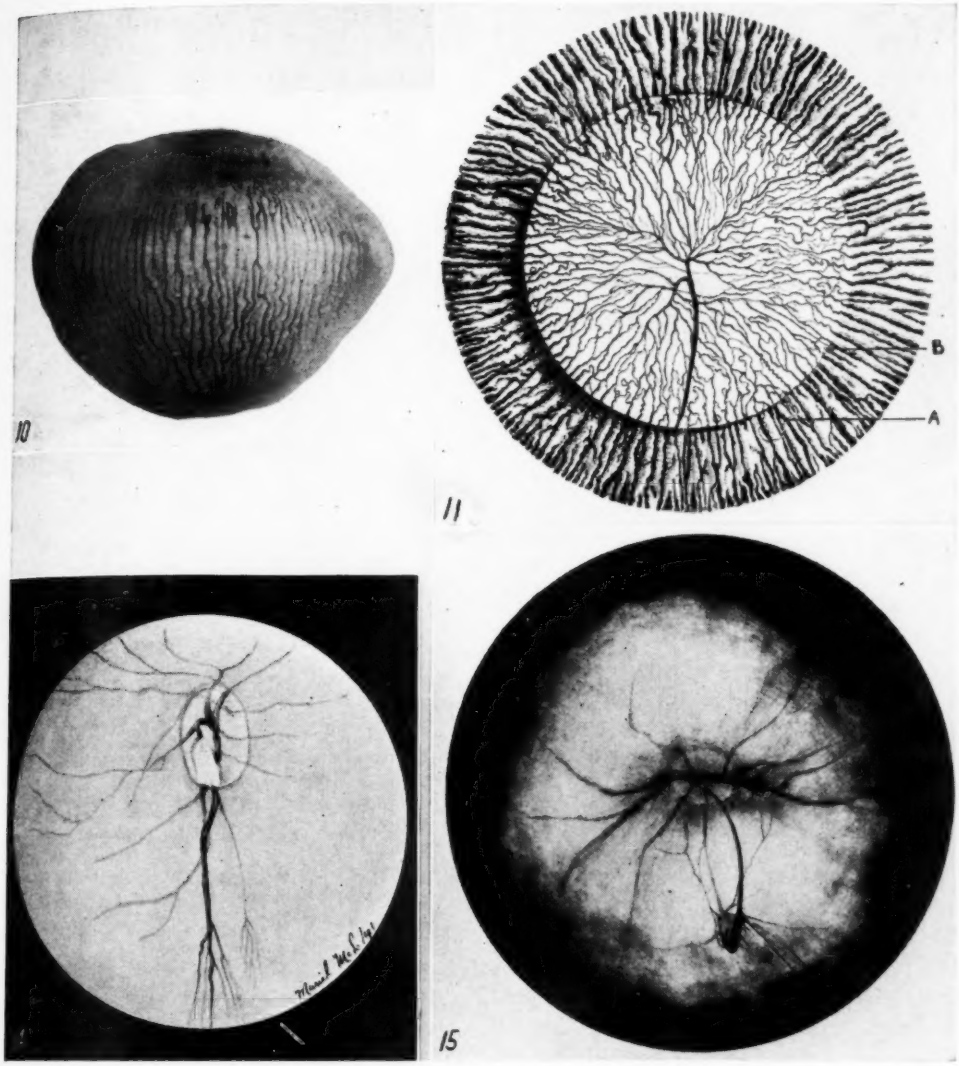


Fig. 10 (Terry). Lateral view of lens from fetal pig eye showing "intermediary" vessels. Note simplification and parallelism of vessels in region of equator.

Fig. 11 (Terry). Artist's drawing of posterior surface of fetal pig's eye. Note exact correspondence of vessels to ciliary valleys. Some of the valleys, however, do not have vessels at this stage. Careful study of the illustration at A shows a vascular loop extending out over the ciliary body. The persistence of this loop indicates that a difference in pressure was maintained between the two vessels from which this loop arises. Another similar but much smaller loop is present at B.

Fig. 14 (Terry). Persistent branching hyaloid artery with epipapillary membrane in a woman aged 36 years. Shadow of hyaloid on retina inserted by artist to enhance three-dimensional effect.

Fig. 15 (Terry). Hyaloid artery in living pig five days old. Retinal vessels were normal red color but hyaloid artery appeared black.

esses arise first because blood vessels are the most plastic portion of the developing organism.* Although in the specimens studied there was not a vessel for every valley, it is possible that the absent vessel had already atrophied.

The anterior or pupillary portion of the tunica vasculosa lentis is developed partly from the "intermediary" portion but largely from buds of the long pos-

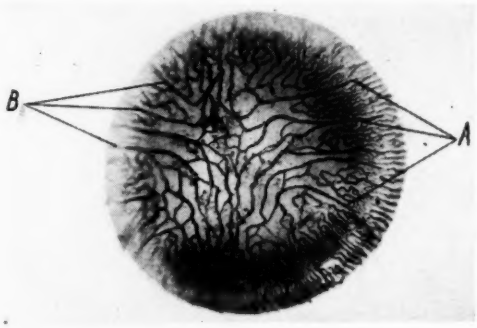


Fig. 12 (Terry). Anterior surface of fetal pig lens. When lens was removed from the eye, some vessels were broken from the iris. These vessels are clearly in focus at A and can be seen hazily at B. As these vessels are seen at either side and not above nor below, their position may be related to the location of the long posterior ciliary arteries.

terior ciliary artery near the annular vessel.[7] After the lens vesicle has developed, the mesoderm lying in front of the lens becomes vascularized by these buds.[11] This membrane can be divided, by the 40-mm. stage, into (1) a central portion, supplied by the long ciliary arteries, and (2) a peripheral portion, which anastomoses with the "intermediary" vessels.

There is considerable difference of opinion as to whether vessels in the pupillary membrane cross the center of the pupillary area. According to Versari,[7] Leber, Henle, and O. Schultze believe that vessels are found, while Cloquet and Jacob think that they are never present. Versari[7] and Mann,[6] however, believe that they can be present at times. In this present study it is evident that no central, vessel-free area is present in the pig at the height of development of the pupillary membrane (fig. 12), and it appears that central vessels are also present in the cat, rat, and human eye.

Early, before little if any iris has developed, the connection between the "intermediary" portion and the pupillary membrane is easily seen. In later stages, the connections are not invariably demonstrable. It is evident, however, that drainage from the tunica vasculosa lentis goes around the pupillary margin into the stroma of the iris directly or indirectly. In spite of a most diligent study of the embryologic specimens, no vascular connection between the hyaloid system and the vessels of the ciliary processes through the ciliary epithelium was observed.

While the tunica vasculosa lentis is developing rapidly, healthy buds project in the direction in which vessels will develop (fig. 13). These buds are composed of cells relatively immature and thick in contrast to those of the more fully developed fetal vessels. Reconstructions of the vessel system showed that occasionally what might be taken for a bud in which a lumen had not yet formed was in reality a tangential section of a vessel that did not quite include the lumen.

Different opinions are to be found regarding forces governing blood-vessel development. In 1893 Thoma[12] postulated the following law: (1) An acceleration of current leads to an enlargement of the lumen of a vessel and a slowing of the current leads to its narrowing and final disappearance. (2) An increase in the blood pressure is the cause for new formation of capillaries. (3) The growth in thickness of the vessel wall depends on the tension of the wall, which, in turn,

*Dr. G. L. Streeter. Personal communications.

is dependent upon the blood pressure and the diameter of the vessel.

However, Clark[13] points out certain fallacies in this postulate. He cites the demonstrations that after removal of the heart in embryos or after inhibition of the heart beat by chemicals or after removal from the body to artificial media, new capillaries send out sprouts which anastomose to form plexuses in the absence of circulation. He also states that if an increase in blood pressure were the determining factor in the formation of new capillaries after the primary differentiation, a greater number of new sprouts would arise from the arterial vessels than from the venules, but observation of growing vessels shows this is not the case.

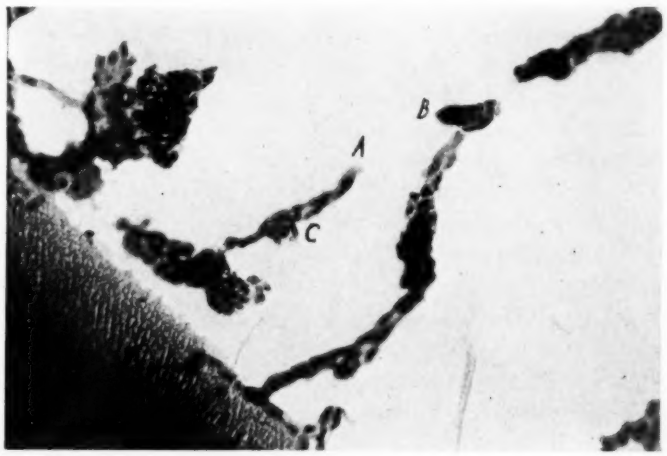


Fig. 13 (Terry). High-power photograph of budding vessel in eye of 22-mm. human fetus. Although it appears in other sections that a vessel may join points A and B, the reconstruction of the eye (fig. 2 A) showed that no connection was present and that projection at A was a bud of embryonic vessel-wall cells, devoid of lumen. Vessel from which this bud arises is seen at C.

A view commonly held by embryologists and anatomists* is that vessels develop an elaborate system because they are needed and in turn when their need no longer exists they tend to disappear. In other words, the blood-vessel system present in the fetus at any stage represents only that needed at the particular stage, and no tendency is seen on the part of blood vessels to develop along a certain predestined pattern to fulfill needs at a later stage of development.

* Streeter, Wislocki. Personal communication.

It is not difficult to surmise why the hyaloid-artery and tunica-vasculosa-lentis system develop. When the lens first appears, it is extremely large in proportion to the rest of the eye (fig. 2 A). Because no aqueous is present at this stage, the growing lens has no other method of nutrition except that supplied by this vessel system.

As the eye enlarges the hyaloid artery and tunica vasculosa lentis do not keep pace with either the general ocular growth or even the progressive lessening in growth rate of the lens (fig. 2 B). According to Versari[7] the hyaloid and tunica-vasculosa-lentis vessel system simply fail to grow and become stretched. As the vessels go around the growing edge of the pupillary margin the drainage of this system is more tortuous. Also the ciliary body becomes capable of producing aqueous, so that there is now a system whereby the lens may obtain nutrition independently of the presence of any vessels. Thus, the demand of the lens for nutrition diminishes.

Normally, regression of the hyaloid system sets in before the main trunk or any of the branches reach a developmental stage approaching that of an adult vessel. The relatively thick cells surrounding the lumen show necrobiotic

changes, breaking away from each other in many instances. Karyorrhexis and karyolysis are much more common than pyknosis. Just as the vessel is breaking up, the cells along the lumen appear to become somewhat separated from each other. In regard to regression, I have no exact data from my material as to just how and where the obstruction of each vessel occurs. Certainly it is evident that the main hyaloid trunk itself closes at some distance behind the lens, usually near the nervehead. The curled remains of the hyaloid artery hanging from the back of the lens[8] so uniformly observed in children and young adults during slitlamp examination is evidence that closure occurs some distance behind the lens. However, magnification gives one the impression that this small remaining piece of hyaloid artery attached to the posterior lens capsule is much longer than it really is. The hyaloid artery must occasionally close at various distances from the nervehead. In one instance examination of a woman 35 years of age showed the remains of the hyaloid artery extending forward from the nervehead to terminate in six-pointed branches (fig. 14). All of these branches appeared to have bright-red blood in them up to their tips. As in the normal retina it is probable that the column of blood only and not the vessel wall was seen. In this event, closed strands of these vessels could extend much farther into the vitreous, even reaching the back of the lens. The red branches did not extend far into the eye. The nervehead was seen with a plus 2D. sphere, and the anterior tip of the remaining hyaloid system was seen with a plus 15D. sphere, thus representing a distance of 13 diopters or 4⅓ millimeters.* Upon rotation of the globe while the observation was being made the terminal branches were seen to be well behind the center of rotation. Judging from the length and number of the vessels these six branches could be interpreted as central remains of the main hyaloid artery and certain of the vasa hyaloidea propria. I have no explanation as to why these vessels appeared to end in such a way that no flow of blood could continue through them, and yet the columns of blood seen were bright red as if the closures were quite recent. The lumen present evidently represented a tube filled with stagnant blood ending blindly. It is possible that changes in intraocular pressure might empty the content of these vessels and perhaps let them refill, thus preventing complete, prolonged stagnation. It was interesting to note that this patient had only 20/50 vision in this eye. The persistence of the hyaloid artery was the only abnormality found in the eye to explain the poor vision.

This observation was in contradistinction to the appearance of the hyaloid artery in a living pig five days of age. The hyaloid was as black as if injected with India ink (fig. 15). Although the hyaloid artery could be followed from the nervehead to the back of the lens where it broke up into several branches, still this vessel appeared black. Blood vessels could be seen in the fundus and were of the normal red color.

Remains of pupillary membrane commonly seen with the slitlamp show that closed vessels may remain as fine strands of slightly opaque or translucent material (plate 7 A, see Frontispiece). Persistence of blood-vessel connection between the intermediary portion and the mesoderm of

* This is based on the common conception that one diopter of difference in height of objects in the fundus represents an actual distance of one-third millimeter. Dr. Elek J. Ludvigh has collected data indicating that one diopter equals a distance varying from 0.247 to 0.513 millimeters in emmetropic eyes.

the iris would behave as a posterior synechia, and persistence of the vessel wall after the lumen had been obliterated would even produce posterior synechia without any inflammatory reaction. The development of pigmentation in the outer surface of the optic cup and on the back of the embryonic iris parallels the appearance of blood vessels in these regions. It is therefore possible for pigmentation to develop in any neural ectoderm adherent to the remains of blood vessels in the region of the lens. If adherent to the lens, these minute remains would take on the typical congenital crowfoot appearance as a result of stretching irregularly as the crystalline lens grew.

The hyaloid artery, at least some of the tunica vasculosa lentis, and a portion of the pupillary membrane are present and can be seen in infants born extremely prematurely. The disappearance of these vessels was followed in a group of normal premature infants. The findings in all these infants were essentially the same. Two cases only, of which artist's drawings were made, are briefly reported.

An infant, born six weeks prematurely, was examined at the age of three days. The remains of a pupillary membrane could be seen running across the pupillary area (plate 7 B). When the baby was three weeks old the pediatrician noted that the vessels were bloodless and barely perceptible, but at the age of one month the cobweb-thin vessels could still be seen.

The mother had been under treatment for hypertensive cardiovascular disease, and pre-eclampsia grade I. The pregnancy was terminated by artificial rupture of the membranes. Vitamin-K therapy was instituted before delivery for the mother, and also administered to the baby shortly after birth. At birth the baby weighed 1,758 grams (3 lbs. 14 ozs.). The postnatal course was uneventful and the infant was discharged from the hospital at the age of one month.

This infant was examined again at the age of 4½ months. The baby's eyes had changed to a dark clear blue, probably their permanent color, as both the parents had blue eyes. No evidence of pupillary membrane could be seen (plate 7 C). Slit-lamp observation showed no vessels in the iris, no hyaloid artery, and both anterior chambers of normal depth.

Another infant, born about 12 weeks prematurely, was examined at the age of four days. The pupillary membrane was clearly visible, and with a plus 8D. sphere branches of the hyaloid artery could be seen on the back of the lens. In this infant the vessels were more numerous, extending nearer the center of the pupil, and making up a finer mesh (plate 7 D).

The course of the pregnancy had been uneventful until the membranes ruptured three days before delivery. Vitamin-K therapy was administered to the mother at the time of delivery, and to the baby soon after birth. The birth weight was 1,389 grams (3 lbs. 1 oz.). The infant was discharged from the hospital at seven weeks of age.

By three weeks of age the pupils reacted promptly to light, and no blood vessels were seen by the pediatrician in the pupillary opening. This infant was also examined again at the age of 4½ months. The color of the eyes had begun to change although the "baby blue" color was still evident. No vessels were seen in the pupillary area (plate 7 C). Slitlamp observation showed no vessels in the iris and no trace of a hyaloid artery; both anterior chambers appeared to be of normal depth.

There is some evidence that aqueous is produced before the iris meshwork and Schlemm's canal are developed sufficiently to allow "filtration" from the eye. If this is so, it is quite probable that physiologic glaucoma is present during the later stages of fetal life, and this would account for the relatively rapid growth of the eye at that time.

Summary

1. In the fetal eye the vitreous contains many fibrils, the presence of which are related, perhaps, to the blood vessels in the vitreous, since this fibrillar structure disappears as the hyaloid-artery system undergoes involution.

2. Normally the tunica vasculosa lentis consists in a network of blood vessels, with no mesoderm filling out the interstices.

3. So-called persistent tunica vasculosa lentis consists in a growth of embryonic connective tissue in the interstices of the persistent tunica-vasculosa-lentis network. It is really a retrolental fibroplasia.

4. The term lateral or capsulo-pupillary for a portion of the tunica vasculosa lentis is confusing. Intermediary portion is the term suggested here.

5. The palisade arrangement of intermediary vessels is to be found only in the region of the equator of the lens where they are in close correspondence with the valleys of the ciliary processes.

6. The direction of blood flow in the hyaloid artery from the optic nerve forward has been verified in fetal life.

7. The anterior portion of the tunica vasculosa lentis or the pupillary membrane has an independent arterial supply although it receives all venous blood from the tunica vasculosa lentis. It is therefore possible to have a persistence of the pupillary membrane without persistence of the hyaloid artery and of the tunica vasculosa lentis.

8. The blood vessels of the pupillary membrane at the height of development cross the center of the pupillary area in pigs, and probably cross over the central area in the cat, the rat, and the human fetus.

9. Tunica-vasculosa-lentis drainage in later fetal life opens into the deeper portions of the iris. Persistence of these connections will result in congenital synechia, and persistence of minute portions that may become pigmented can develop into typical congenital crowfoot pigment.

10. Closure of the hyaloid artery is not invariably in the same location.

11. In infants born sufficiently prematurely the pupillary membrane can invariably be observed with ease, and the presence of the posterior part of the tunica vasculosa lentis and hyaloid artery can usually be determined, because these vessels do not involute until late in fetal life.

12. A relationship between rapid growth of lens and wide extension of the hyaloid arterial system is probable, as the disappearance of the hyaloid system occurs concurrently with the development of another method of nutrition for the lens; namely, formation of aqueous humor.

13. Aqueous development before the filtration angle is functioning could explain the rapid growth of the eye in late uterine and early infantile life, at which time physiologic glaucoma may be present.

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FOCAL INFECTION*

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One of the most important doctrines in American ophthalmology is the belief that certain inflammatory ocular disorders are caused by remote foci of infection—the theory of focal infection. This concept of the cause of certain systemic diseases and remote localized inflammations was introduced by Hunter in 1901,[1] and was elaborated chiefly by Billings from 1910 to 1916. During this same period E. C. Rosenow published his dramatic reports on the transmutation of bacteria, and the experimental production of diseases of joints, endocardium, gall bladder, stomach, duodenum, and other organs by the injection of bacteria isolated from similar disease foci in humans. In 1916 Billings[2] in his Lane Medical Lectures reviewed the entire subject of focal infection to date, presented the clinical and experimental observations which he believed substantiated the theory, removed it from the general class of theories, and established it on a scientific basis.

This theory as presented by Billings, in 1916, may be summarized as follows: A primary focus of infection is a circumscribed area of tissue infected with microörganisms and located usually in the tissues communicating with a mucous or cutaneous surface. From this primary focus of infection, either by hematogenous or lymphogenous pathways, usually the former, systemic infection and intoxication may occur, and the infecting organisms spread to other remote tissues of the body and there produce secondary foci of infection.

The primary focus of infection may be in the teeth in the form of a periapical abscess or pyorrhea alveolaris, in the tonsils, in subcutaneous abscesses, in the accessory nasal sinuses; in the respiratory tract, including bronchiectasis; in the gastrointestinal tract, including the rectum with its rich supply of hemorrhoidal veins; in the auxiliary organs of digestion, including such conditions as cholecystitis, appendicitis, intestinal ulcers, and intestinal stasis; in the genitourinary tract, including conditions such as endometritis, salpingitis, seminal vesiculitis, prostatitis, cystitis, and pyelitis. From such primary foci the adjacent lymph nodes may become secondarily affected, so that even after the eradication and healing of the primary focus the secondarily infected regional lymph nodes may remain as reservoirs

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from which the infection may spread.

The infection in these primary foci is exogenous. In the mouth this may arise from the normal bacterial flora, assisted by the action of Entamoeba buccalis, with resulting infection of the peridental membrane and subsequent pyorrhea and periapical abscesses. The tonsils become infected by contaminated air and infected food. Obstruction of the upper air passages prevents proper drainage of the nasal cavities and in turn produces infection of the accessory nasal sinuses, middle ear, mastoid, mucous membranes of the nose, and later of the bronchi. Focal infection of the gastrointestinal tract may arise from autoinfection or autointoxication of the intestinal tract, including intestinal stasis. The gall bladder, stomach, pancreas, and appendix may be secondarily involved by hematogenous infection from an original primary focus in the teeth, tonsils, or nasal sinuses, and may thereafter serve as primary foci for further infection. The genitourinary tract may become infected by pyogenic bacteria at childbirth, by abortion or miscarriage, and especially by venereal infection with the Gonococcus.

From the primary foci of infection disease is assumed to spread to other portions of the body. The reason why all individuals do not become ambulant museums of pathology (since more or less primary infection is inevitable in even the most carefully regulated existence) is, first, on account of the normal resistance mechanism of the body, the leucocytes, phagocytes, and the like, and, second, by the formation of specific antibodies against the infecting microörganisms that neutralize their harmful effect and inhibit their activity. Certain individuals are naturally more susceptible to infection than others, and it is in such individuals especially that secondary infection takes place. The susceptibility to secondary infection is increased by debilitating disease and exposure to cold with the resulting vaso-constriction.

The mechanism of the secondary infection is usually hematogenous by direct bacterial metastasis from the primary focus through the blood stream. Lymphogenous infection is usually limited to direct extension from the primary focus to the adjacent lymph nodes, where a secondary reservoir of infection may be established. The possibility of the influence of exo- and endobacterial toxins is also mentioned by Billings, and the possible importance of sensitization of the tissues from the primary focus is likewise briefly discussed, but dismissed as a subject for further investigation. The local reaction in remote lesions secondary to a primary focus is endothelial proliferations of the lining of the blood vessels with or without thrombosis, but resulting in blocking of the vessels with hemorrhage into the immediate tissues, positive chemotaxis with multiplication of the leucocytes and plasma cells, and in cases in which the infecting organisms are of low virulence, fibrinoplastic exudate with connective-tissue proliferation.

Secondary, or systemic disease from a primary focus may affect various tissues of the body. The usual acute diseases believed produced by focal infection are listed by Billings as acute rheumatic fever, endocarditis, myocarditis and pericarditis secondary to rheumatic fever, pancreatitis, chorea, systemic gonococcus infection, gonococcal arthritis, acute nephritis, cholecystitis, acute gastric and duodenal ulcer, erythema nodosum, acute osteomyelitis, and diseases of the eye, especially iridocyclitis and uveitis.

The evidence in favor of this concept of focal infection, as outlined by Billings and others, is as follows: *First,* small primary foci of infection are constantly

found in association with these secondary systemic and focal diseases, and quite frequently there is no other cause, such as syphilis or tuberculosis, to account for the secondary disease. *Second,* there are evidences of transient bacteremias in individuals who have small primary foci of disease and secondary systemic disease. Such are the recovery of Streptococcus viridans from the blood stream of individuals suffering from early endocarditis, the report by Rosenow[3] that in acute rheumatic fever the same Streptococcus can be simultaneously isolated from the affected joint exudate and capsule, from the tonsils, alveolar processes of the teeth, and the circulating blood; and a similar report by Billings that in chronic endocarditis the Streptococcus viridans can be simultaneously isolated from the alveolar process of the teeth and the circulating blood. *Third,* the selective affinity of certain bacteria for certain tissues. This property Billings believed was fully established by the experimental work of Rosenow,[4] which indicated that organisms isolated from certain diseased organs or tissues of patients, when injected into animals, produced practically identical lesions in the corresponding tissues or organs of the experimental animal, with far greater frequency than was observed in the controls. This property of elective affinity, or tropism, might be produced or enhanced by cultivating the organisms on media containing the specific tissue. *Fourth,* the well-known and recognized exacerbations of arthritis, myositis, or iridocyclitis that often followed early or radical surgery on the primary focus, this arguing strongly for a causal relationship between the two diseased areas. *Fifth,* the again well-known and recognized clinical improvement that so often occurs in the systemic or secondary disease when the primary focus is eradicated, which was assumed to indicate an end to the bombardment of the secondarily diseased tissue by transient bacteremias from the primary focus.

This theory offered a ready and plausible explanation for many of the problems of localized endogenous infections. When frank sepsis was not apparent, the manner in which such protected structures as the endocardium, the joints, and the uveal tract of the eye might become infected with bacteria had never been clear. If primary diseased foci, such as the teeth, tonsils, and genitourinary tract, which might obviously become infected from external sources, could produce a transient bacillemia and the bacilli thus introduced in the blood stream lodge in the endocardium, joints, eyes, and elsewhere, the etiology of infections of these tissues was clear. Thus the theory of focal infection offered a logical solution for the problem.

Like all new theories, this idea was immediately accepted by many without question, and there ensued a widespread and somewhat indiscriminate eradication of primary foci of infection as a therapeutic procedure for an almost infinite number of pathologic conditions. The literature soon became filled with glowing reports of brilliant cures of various obscure diseases following the removal of the teeth, the tonsils, the drainage of the accessory nasal sinuses, and such procedures. However, it soon became apparent to all, except the most rabid advocates of the doctrine of focal infection, that in many instances the sacrifice of the teeth, the removal of the tonsils, and the like, was without any effect on the diseased condition for which the procedure had been undertaken, and the final condition of the patient was no better, but indeed often worse than before his submission to these various surgical ordeals. These unhappy results were boldly discounted by the focal-infection

advocates as due either to the spread of the primary focus beyond the bounds where it could be completely removed, or to the already firm establishment of the secondary focus.

Other observers and investigators, more critical and less credulous, questioned various points of the theory, and sought an explanation of several pertinent questions that could not be accepted on faith alone. The elective affinity of bacteria for specific tissues, and the question of transmutation of bacteria was immediately questioned by many bacteriologists and pathologists. It was likewise pointed out that primary foci of infection were very frequent and often multiple in many normal individuals, and that it was peculiar that the secondary disturbances in the joints, the endocardium, or the eye, should be caused by rather small foci in the teeth or tonsils, and not by such massive infections as empyema or psoas abscesses. Some means of determining if a demonstrable focus of infection was causally related to the secondary disease was therefore sought. To this end the primary focus was cultured and tests were made to determine if the affected individual was unduly sensitive to the specific organism isolated from the primary focus. The complement fixation and the agglutination reaction of the blood serum were employed to ascertain if there was any undue systemic reaction to the organisms cultured from the primary focus and, if so, what fraction of the general antigenic mosaic, the filtrates, exotoxins, or nucleoprotein of the bacterial body might be responsible for such reactions. These laboratory investigations were in the main futile, the general run of all normal and diseased individuals showing more or less reactivity to the organisms in the primary foci, to which they were constantly exposed.

However, despite these various objections and much negative laboratory investigation, in the decade following Billings's articles the doctrine of focal infection became firmly ingrained in American medical practice, and the search for primary foci of infection and their eradication when possible became the generally accepted procedure in the treatment of many localized infections, especially endogenous diseases of the eye, for which there was no obvious explanation, such as syphilis. In 1928 the literature, including laboratory investigations, was summed up by Holman[5] in a critical review. While accepting a causal relationship in many instances between primary foci of infection and remote disease, he pointed out the extreme diagnostic acumen required to decide if any determined focus of infection was causally related to the secondary disease, and that efforts to develop procedures of any diagnostic accuracy to determine this had been fruitless. In reviewing the evidence in favor of a relationship between primary foci of infection and secondary disease, Holman pointed out there was some suggestive evidence in the studies of sensitivity to the organisms from the primary focus which might indicate an undue reaction to these bacteria. The dissemination of organisms from the tonsils and teeth was, to a large extent, due to local anatomic peculiarities. As a result of exogenous infections, such as cause the common cold, the crypts of the tonsils may close and ulcers form in the base of the crypts. The epithelium of the crypts differs from that of the tonsils proper, having papilli and an underlying rich network of capillaries.[6] This epithelium is destroyed in chronic tonsillitis, and pressure on the tonsils can force bacteria into the circulation.[7] The constant periodic compression of the tonsils in the act of swallowing suggests that this may be the mechanism by which bacteria from the tonsils

gain access to the blood stream. In the case of the teeth, the thinness of the epithelium covering the gingival crevices, the occasional breaks in its surface, and imperfect junction make this a weak point, where bacteria gain access and produce pyorrhea alveolaris.[8] Periapical abscesses may arise secondary to either pyorrhea or from the root canal of infected teeth. The rich capillary circulation of the gums facilitates entry of the bacteria to the blood stream. The evidence in favor of the gastrointestinal tract acting as a focus of infection was analyzed, but no definite conclusions were reached. Holman then reviewed the extensive literature on the relation of cholecystitis, pancreatitis, and nephritis to focal infection, and emphasized that in each instance the anatomic peculiarities play a large role in the localization of bacteria in these structures. Rheumatism and joint diseases present a most complex problem, and Holman stated quite definitely that the extensive investigations on these subjects indicate that the fundamental basis of all these rheumatic manifestations is a condition of hypersensitiveness to numerous exciting causes. The influence of other factors, common colds, heat and cold, diet, vitamin deficiency, and fatigue in the production of focal infection was clearly indicated by many investigators on these subjects. However, the elective localization of bacteria, held by many as sufficient cause in itself to account for the localization of focal infection, was held by Holman not to have been confirmed. The weaknesses of Rosenow's experimental work were pointed out, and the extensive investigations on the subject reviewed. While Holman conceded that a general bacteriologic adaptation to environment is universally accepted and cannot be denied, and while it is clearly proved that streptococci can cause certain lesions throughout the body, nevertheless, it is a 50-percent chance whether any particular localization occcurs with a "specific" or "nonspecific" strain. Summing up the extremely extensive literature, Holman concluded that the doctrine of focal infection has changed from a theory to a definite principle of great importance in numerous diseases of man. The factors determining the localization of bacteria in any tissue are those that alter the nutrition of the cells of those tissues, particularly the endothelium of the capillaries. The factors determining the invasion of the bacteria from the primary focus are dependent largely on the local circulation about or in the focus, especially dilatation of the capillaries and sluggish circulation. However, when a focus of infection is discovered, and considered responsible for a diseased condition, it requires the highest type of diagnostic ability to prove this is true. The recovery of the patient is insufficient, for this may be due to the general tonic stimulus resulting from the removal of one cause of lowered systemic resistance. Failure to effect a cure is likewise insufficient evidence against the relationship of the primary focus to the disease, for the secondary disease is often so well established when the primary focus of infection is discovered that the damage already done is irreparable.

The case for focal infection, even with the conservative reservations of Holman, was, however, far from settled. The critics of the theory freely conceded that in the sense gonorrheal arthritis was related to gonorrhea, furuncles to septicemia, tetanus to a localized infection with tetanus bacilli, the origin of such systemic diseases to primary foci of infection was well established; but the idea that various diseases of unknown origin are related to infections of the teeth, tonsils, and other such localized foci met with steadily increasing opposition. In

1940 the views of this opposition and the supporting evidence were ably summarized by Reimann and Havens in a well-documented review.[9]

Reimann and Havens especially analyzed the evidence against infected teeth or tonsils being related to remote localized disease. The evidence against so-called "infected" teeth acting as a reservoir whence infection might be disseminated to remote tissues of the body was summarized as follows: *1.* The bacteriologic studies of apically infected teeth are questionable on account of the technical difficulty of preventing contamination during extraction,[10] so that even when bacteria are present there is usually no evidence of infection of the adjacent tissues, and the mere presence of bacteria does not mean they are pathogenic. *2.* The diagnosis of periapically infected teeth is usually made by roentgenologic study. This may be fallacious, for many of the radiolucent areas about the roots of teeth are not caused by infection.[11] It is impossible to estimate the pathologic significance of such abnormalities by roentgenographic studies alone, and radiolucent areas often disappear spontaneously if let alone.[12] *3.* The results of inoculation experiments with organisms isolated from infected teeth are all sharply in contradiction to Rosenow's experiments, and these views on elective localization, which form such a cornerstone for the focal-infection theory, should not only be disregarded but actively contradicted.[13] *4.* The reports of clinical improvement following extraction of teeth must be accepted guardedly. The improvement may be due to the shock reaction following extraction, and is often temporary. The actual evidence is against extraction of the so-called infected teeth benefiting arthritis. Thus Cecil and Angevine[14] reported on 52 arthritic patients who had had all teeth removed, 47 receiving no benefit from this dental assault, while 3 were made worse. Further, Reimann quotes Bauer's experience in the treatment of a series of 300 arthritic patients, those with their teeth let alone doing better than those subjected to oral surgery. The existing clinical evidence does not indicate any causal relationship of infected teeth to either nephritis or rheumatic heart disease.[15] *5.* Far from being of benefit to the patient, the extraction of teeth may be positively dangerous, the bacteria being actually forced into the blood stream by the trauma of operation. Okell and Elliott's[16] bacteriologic study of the circulating blood immediately after the extraction of teeth revealed Streptococcus viridans in 75 percent of such blood cultures. It is true, however, that such transient bacillemias are usually harmless. Further, lung abscesses may follow the extraction of teeth, due to the aspiration of infected blood or tissue particles, 12 percent of a series of 227 lung abscesses being due to this cause.[17]

The evidence against the tonsils being related to such diseases as rheumatic fever, rheumatoid arthritis, colds, subacute bacterial endocarditis, nephritis, and a host of other conditions charged to their account is even more convincing. Barring repeated attacks of tonsillitis, or peritonsillar abscesses, for which of course tonsillectomy is indicated, there is no definite standard to judge whether or not tonsils are chronically infected. In a series of scholarly articles, in which he stressed the impossibility of sterilizing the mucous membranes of the throat, Bloomfield[18] emphasized the fact that bacteria normally grow not only on the mucous membranes but in their superficial layers, in the crevices between the epithelium, and in the orifices of the small mucous glands. Long[19] studied 2,000 pairs of extirpated tonsils and rarely found abscesses. The Streptococ-

cus viridans, to which so much importance is attached by the advocates of focal infection, is a part of the normal bacterial flora in the mouths of healthy individuals.[20]

Although there are apparently many instances in which acute rheumatic fever follows an attack of acute tonsillitis, various clinical studies indicate that in from 25 to 90 percent of cases of rheumatic fever there are preceding conditions other than tonsillitis or respiratory tract infections, and that in spite of the wholesale removal of tonsils over the past three decades the incidence of acute rheumatic fever is not lessened.[21] There have been numerous comparisons of the incidence of rheumatic fever and cardiac disease in children who had had their tonsils removed and those who had not. There is no significant reduction in initial infection, recurrence, or subsequent heart disease in the children who have had their tonsils removed,[22] and the number of recurrences of rheumatic fever has not been reduced by tonsillectomy.[23]

Rheumatoid arthritis appears to be no more affected by tonsillectomy than is acute rheumatic fever. Statistical studies show that regardless of the type of treatment used in rheumatoid arthritis, 25 percent "recover," 50 percent improve, and 25 percent get worse. Pemberton's[24] study of 400 cases, in which he showed that 46 percent recovered without operative attack on the supposed foci of infection, while only 16 percent recovered after operation, therefore does not lend much support to the advocates of tonsillectomy. Likewise it was pointed out that children who have rheumatoid arthritis rarely show other evidence of localized infection.

Further statistical evidence of the apparent harmlessness of the tonsils in children was presented in the study of Cunningham,[25] who in 14,000 students found no greater cardiac change in those who had either normal or diseased tonsils, and those whose tonsils had been removed; of a British Commission[26] which investigated 30,000 school children, and found the incidence of colds, coughs, and sore throats did not differ in those with and without their tonsils; and of Ellis and Russell,[27] who studied 4,000 Basque refugee children from the Spanish War, of whom less than 2 percent had had their tonsils removed, and even among those with their tonsils as large as walnuts, found an incidence of cervical adenitis and otorrhea of only 0.4 percent.

Finally, to illustrate how far the pendulum has swung away from the idea of focal infection from the teeth and tonsils, and their removal as a therapeutic procedure, may be cited the changed position of such a careful student as Cecil. In 1933 he[28] wrote, "the keystone of the modern treatment of rheumatoid arthritis is the elimination of infected foci." In 1938, after prolonged study, in collaboration with Angevine,[14] he stated that in no instance was the course of the disease altered or the patient cured when supposed foci were removed. He now believes that focal infection plays a relatively unimportant role in the disease. Bloomfield, who always found great difficulty in assimilating the tenets of the focal-infection doctrine,[29] regards the procedures of extraction of teeth and extirpation of the tonsils as a gesture or the remnant of a habit which enables one to do something in chronic cases in which there is actually so little to do.

Summing up the case for the opponents of the theory of focal infection, Reimann and Havens freely concede that teeth should be removed or treated when there is reasonable certainty of their infection or of apical abscess; and tonsils that are the site of repeated attacks of

illness, should be removed. However, they maintain that the theory of focal infection has not been proved, that the infectious agents are unknown, that large groups of persons whose tonsils are present are no worse off than similar groups whose tonsils have been removed, that patients who have given up their teeth and tonsils in the hope of alleviating some systemic disease have often, if not usually, made the sacrifice in vain, that when beneficial effects are observed they can seldom be ascribed to the surgical procedures, that the rare beneficial effects are outweighed by the harmful effects, or no effect at all, and finally that many supposed primary foci of infection heal spontaneously after recovery from the systemic disease, or when the general health is improved by hygienic or dietary measures.

Thus today stands the case of focal infection. It is probably a conservative statement to say that before an audience of bacteriologists, pathologists, and internists, the doctrine of focal infection stands on a shaky pedestal and clad in somewhat dilapidated raiment. Among ophthalmologists, however, the case is somewhat different. It is a matter of established routine, in almost all American ophthalmologic clinics, to make a search for foci of infection in the study of the etiology of uveal-tract disease, and usually to recommend the removal of discovered foci, as far as possible, as a therapeutic procedure in the treatment. So far has this idea been ingrained that even before routine cataract or glaucoma operations on noninflamed eyes, the removal of obviously infected teeth or tonsils has been advocated as a precautionary measure calculated to lessen the incidence of postoperative complications, the theory being that the trauma of operation may favor the localization in the eye of bacteria from a remote primary focus. True, here and there voices have been raised among thoughtful ophthalmologists questioning the blind acceptance of the theory of focal infection, and Verhoeff along such lines has stated, "Belief in focal infection must be taken like religion, on faith." In recent years the realization that many cases of uveal-tract disease, which might formerly have been believed due to foci of infection, are in reality due to tuberculosis or other infectious granulomata, has somewhat lessened the percentage of cases attributed to focal infection. Nevertheless, the doctrine of focal infection, correctly or incorrectly, occupies a strongly entrenched position in ophthalmology, and it should not be relegated to the unimportant status it enjoys among bacteriologists and internists until the specific evidence for and against it has been carefully examined.

The ophthalmologic literature bristles with reports, too numerous to list, of the dramatic recovery of patients suffering from iritis, choroiditis, uveitis, and even optic neuritis of one type or another, following the removal of foci of infection, usually in the teeth, tonsils, or accessory nasal sinuses. In these patients there was present no other demonstrable systemic disease such as syphilis, tuberculosis, or other process. In the case of optic neuritis there was likewise no evidence of disseminated sclerosis or other conditions to which the ocular disease might be attributed. There can be no doubt of the accuracy of these observations, for they have been a matter of common observation in the practice of the majority of ophthalmologists. However, it is also true that many cases of iritis and choroiditis of undetermined etiology recover spontaneously. It is likewise true that optic-nerve disturbances occur often in disseminated sclerosis as the first evidences of the disease, and retrobulbar neuritis may subside and the patients enjoy long

remissions before recurrences in the optic nerve and elsewhere reveal the true nature of the disorder. The healing of an ocular lesion following removal of a remote, infected focus can therefore be accepted only as suggestive evidence of a relationship between the ocular lesions and the infected focus. Nevertheless, this mass of clinical evidence, consisting of careful studies on the etiology of uveal-tract disease and case reports illustrating the recovery of the diseased eye on removal of foci of infection, is so formidable that it is difficult to dismiss it lightly on the sole grounds that it is only suggestive evidence. It is necessory, therefore, in analyzing the theory of focal infection as it relates to ophthalmology, to examine carefully the clinical, experimental, bacteriologic, and immunologic evidence that may argue for or against this theory.

Many of the reports on the relationship of uveal-tract disease to focal infection emphasize some special etiologic factor. The following are typical examples: Benedict[30] reported 14 cases believed to be caused by infections in the female pelvis, the usual organism being a green streptococcus. Kapuscinski[31] reported 51 cases of iridocyclitis caused by infections about the teeth, and healing after extraction of the diseased teeth. Mazal[32] reported cases due to infected teeth, sinusitis, and appendicitis. Zanettin[33] compared the incidence of the occurrence of foci of infection in noninfectious and in inflammatory ocular diseases. In 87 patients in the first category he found only a 16-percent incidence of foci of infection; in 26 patients in the second group, 57 percent had infected tonsils; and in 16 patients the organisms were cultured from the primary focus and in 16 instances the organisms were found to be oculotrophic on animal inoculation. Wulkow[34] reported 22 cases of ocular disease of unclear etiology, of which 13 healed and 9 were improved after the extraction of infected teeth. Johansson[35] believed a latent phlebitis might often be the cause of iridocyclitis. Küchler[36] emphasized the relationship between iritis and infected teeth. Havlik[37] studied 2,458 cases of routine tonsillectomy and found ocular complications, chiefly iridocyclitis, in seven patients, in four of whom the condition cleared after the tonsillectomy. The importance of focal infection as a cause for optic neuritis and retrobulbar neuritis was emphasized by Trumbo[38] and Kapuscinski,[31] who reported 27 such cases due to infected teeth, by Duggan and Chitnis,[39] and by many others. These are all fair samples of the innumerable reports emphasizing the relationship between ocular disease and foci of infection. An especially interesting study was made by Enroth,[40] who studied the influence of the weather on ocular disease apparently due to foci of infection, and found that a great number of the cases of iritis occurred when there was a sharp climatic change, a finding in line with Billings's earlier idea that exposure to cold influenced the capillaries and predisposed to the outbreak of secondary infections.

The majority of the reports, as exemplified by those just cited, are open to the criticisms, (1) they do not give the complete material from which the cases reported are drawn; (2) they emphasize some one factor believed to be of importance, and do not give a comprehensive picture of possible etiology; (3) they do not allow deductions as to the relative importance of focal infection as compared to other possible etiologic factors.

There are, however, several reports which meet these criticisms, four of which may be reviewed here because they illustrate the gradually changing opinion on the relative importance of tuberculosis and focal infection in ophthalmology. The

first two of these are by Irons and Brown[41] and appeared in 1916 and 1923, in the early flush and full popularity of the focal-infection theory. These reports have been widely quoted and have greatly influenced ophthalmologic thought.

These studies each reported 100 cases of iritis studied completely, according to the ideas then prevalent, in the effort to determine the causes of the ocular inflammation. The results of these two studies are summarized in table 1.

TABLE 1

SUMMARY OF IRONS AND BROWN'S STUDIES ON ETIOLOGY OF IRITIS 1916 AND 1923

	Syphilis with or without Focal Infection	Tbc.	Focal Infections						
			Teeth	Tonsils	Gonococcal Infections	Sinuses	Other Infections	Combined Infections	Undetermined
1916	23	8	18	16	9	3	5	17	1
1923	15	0	9	37	1	1	4	24	9
Total	38	8	27	53	10	4	9	41	10
Percentage	19	4	13.5	26.5	5	2	4.5	20.5	5
			Total due to focal infection 144 cases, or 72 percent						

Thus in 200 cases of iritis, 19 percent could be attributed to syphilis, 4 percent to tuberculosis, and 72 percent to focal infection, while in 5 percent the cause was undetermined. The low incidence of syphilis was undoubtedly due to the relatively high social stratum of the patients studied. The small number of cases attributed to tuberculosis is an accurate reflection of the then prevailing thought in America on the unimportance of tuberculosis as an etiologic factor in uveal disease. Only outspoken cases of tuberculous iritis, with evidences of active systemic tuberculosis, were accounted as tuberculous. The outstanding feature of these studies is that 72 percent of the 200 cases were definitely diagnosed as due to remote foci of infection, and in only 5 percent was the cause of the iritis undetermined. A further follow-up study on 50 of these cases was reported by Irons and Brown in 1926.[42] Twenty-three of their patients had had previous attacks of iritis, and 27 had had their first attack at the time they were first seen. Forty-three of these 50 patients had had complete freedom from iritis for periods of from 3 to 12 years; in 38 of these, the original iritis had been attributed to foci of infection, which had been eradicated, in the other 5 it was considered due to syphilis and tuberculosis, which had been treated with antisyphilitic therapy or tuberculin. In seven cases in which the iritis recurred, one was probably tuberculous, two were due to old gonococcal infection with arthritis, one to syphilis, two to foci of infection which had not been removed, while in the seventh case the cause was undetermined. It is scarcely a matter of wonder that this impressive evidence, from such careful students as Irons and Brown, had the tremendous influence it did in ophthalmologic thought.

The third report is by Irons in 1931.[43] In this paper he suggests there may be relative differences in the etiology of acute, recurrent, and chronic iritis. He defines chronic iritis as one of over three

months' duration. He reports a small, carefully studied series of cases, in which 56 percent of 26 cases showed evidence of tuberculosis, 15 percent being probably due to tuberculosis.

The fourth report is from the Johns Hopkins Hospital[44] and is a survey of 562 patients who had endogenous iritis or uveitis and were studied in the wards of the Wilmer Institute from 1926 to July 1, 1939, to determine the etiology of the ocular disease. Patients suffering from uveitis who were admitted for some special diagnostic procedure and on whom the records were incomplete were not included. The material therefore consisted of patients in whom the uveal disease was so severe that hospital care was indicated, or who were admitted to the hospital primarily for diagnostic study. The material may therefore be colored in that the uveal disease was more severe than the usual run-of-the-mine iritis or uveitis, and that it may include a number of suspected cases of tuberculous uveitis referred for the reason that ocular tuberculosis has been a subject of especial study in the Wilmer Institute. In all of these patients the diagnostic study comprised a complete history, general physical examination, clinical and radiologic examination of the teeth, nose, and throat, gynecologic or genitourinary examination, routine laboratory examination of the blood and urine, Wassermann reactions, and Mantoux intracutaneous tuberculin reactions. Roentgenologic examinations of the gastrointestinal tract and gall bladder, bacteriologic studies, and such special tests as the Frei test were made when indicated. Roentgenographs of the chest were made in many instances prior to 1935, and routinely from 1935 to the end of the study. In the latter years gonococcus complement-fixation reactions on the blood serum were routine. Serologic studies for Brucella infection and the examination of biopsy specimens of lymph glands for sarcoid were not routine until 1939. This study is therefore of no value in reflecting the etiologic importance of these diseases.

TABLE 2

ANALYSIS OF 244 CASES OF UVEITIS, WITH DEFINITE DIAGNOSIS OF ETIOLOGIC FACTOR RESPONSIBLE (GUYTON AND WOODS)

	Syphilis	Tuberculosis	Foci of Infection	Gonorrhea	Nongranulomatous Systemic Disease	Miscellaneous, Herpes, Brucellosis, Sarcoid, and Others
Number of cases	45	132	31	10	14	12
Percentage	18.4	54.1	12.7	4.1	5.7	4.9

The patients in the study were divided into two groups. The first group consisted of 244 patients in whom the results of the diagnostic study and the therapeutic response to treatment were so clear that a definite diagnosis of the etiologic factor responsible for the ocular disease appeared justified. Data from these patients are given in table 2. In 45, or 18.4 percent, the uveal inflammation was due to syphilis; in 132, or 54.1 percent, to tuberculosis; in 31, or 12.7 percent, to foci of infection; in 10, or 4.1 percent, to gonococcus infection; in 14, or 5.7 percent, to acute systemic disease; and in 12, or 4.9 percent, to miscellaneous conditions such as herpes, sarcoid, and other processes. The patients in whom the uveitis was attributed to foci of infection had either apically infected teeth, infected

tonsils, infection of the accessory nasal sinuses, or chronic nonspecific infections in the genitourinary tract. In these patients there appeared a causal relationship between the foci of infection and the ocular disease, and the therapeutic response to the eradication of the focus of infection seemed such as to justify this assumption.

The second group consisted of 318 patients in whom the diagnostic study revealed no evident clear-cut etiologic factors to which the uveal inflammation could be attributed, and for whom only a presumptive diagnosis, therefore, appeared justified. Fourteen, or 4.4 percent, of these patients had syphilis, but the occurrence and character of the uveal disease did not altogether fit in with the usual picture of ocular syphilis. In 147, or 46.2 percent, the ocular inflammation was believed to be tuberculous in origin, but for these patients there was insufficient evidence to make other than a presumptive diagnosis. In 116 patients, or 36.5 percent of this group, definite foci of infection were found, but in none of them was there any evidence that the focus of infection was causally related to the ocular inflammation. In the greater number the foci of infection were operated on and eradicated on account of the local condition, and in the hope that such eradication might improve the general resistance and local eye disease of the patient. In none was the result sufficiently striking to suggest a relationship between the focus of infection and the inflammation of the uveal tract. The conditions observed in these 116 patients may have been examples of a latent ocular tuberculosis, of obscure etiologic factors that defied detection, or possibly examples of uveal disease secondary to foci of infection, but so firmly established that eradication of the foci was without effect on the ocular picture. In 16, or 5.0 percent, there was some evidence that gonorrhea might be the cause of the ocular disease, but such evidence was inconclusive. In the remaining 25 patients, 7.9 percent of the entire group, no cause was found to which the uveal inflammation could be attributed, and it was assumed that either the original cause had been some systemic infection which had passed and left the ocular disease as its only residuum, or that the actual cause was so obscure as to be beyond the means of modern medical diagnostic procedures to detect it. The composite figures for both groups are shown in table 4.

TABLE 3

ANALYSIS OF 318 CASES OF UVEITIS, WHERE ONLY PRESUMPTIVE DIAGNOSIS COULD BE MADE

	Syphilis	Tuberculosis	Foci of Infection	Gonorrhea	Nongranulomatous Systemic Disease	Miscellaneous, Herpes, Brucellosis, Sarcoid, and Others
Number of cases	14	147	116	16	19	6
Percentage	4.4	46.2	36.5	5	6.0	1.9

A summary of these four papers on the etiology of uveal disease is shown in table 5. The difference in importance attributed to focal infection and tuberculosis is striking. It is certainly more than can be explained either on the basis of the greater chronicity of the cases of uveitis, the differences in the material studied, the changes or amplification in diagnostic study between 1916 and 1940,

TABLE 4

ANALYSIS OF 562 CASES OF UVEITIS, DEFINITE AND PRESUMPTIVE DIAGNOSIS OF ETIOLOGY

	Syphilis	Tuberculosis	Foci of Infection	Gonorrhea	Nongranulomatous Systemic Disease	Miscellaneous
Number of cases	59	279	147	26	33	18
Percentage	10.5	49.7	26.1	4.6	5.9	3.2

the individual interpretation of different observers or on the correlation of clinical-pathologic material. It illustrates the change of opinion in the course of two decades on the relative importance of tuberculosis and foci of infection as causes of uveal disease, and the decline of the implicit belief in the doctrine of focal infection.

A moderate amount of experimental work has been done, dealing with the relationship of ocular disease and focal infection. Zanettin[45] cultured bacteria from supposed foci in the tonsils, teeth, or genitourinary tracts in 19 patients who had iritis, and inoculated a large series of rabbits intravenously with these organisms. In 64 percent of the inoculated animals a violent congestion of the iris occurred, the same phenomenon persisting in the second transfer. Traut[46] cultured pleomorphic streptococci from the circulating blood of five patients suffering from acute iritis, thus demonstrating that a bacteremia might occur in the acute stages of the disease. Berens and his coworkers have published a series of studies dealing with the relationship of ocular disease to foci of infection. In the first report[47] they described studies indicating that a high agglutinin titer to an autogenous strain of streptococci cultivated from a focus of infection was strong presumptive evidence that the strain was related to ocular disease. In a second experiment[48] they injected rabbits intravenously with organisms isolated from the teeth and tonsils of patients with inflammatory ocular disease, and obtained an iritis in 44 percent of 61 different strains, while in a control group of 69 stock strains of organisms, iritis occurred in only 29 percent of the inoculated animals. In a third paper[49] they studied the ocular lesions resulting from single and multiple injections of various organisms, and found that iritis and microscopic lesions of the uveal tract might occur fol-

TABLE 5

SUMMARY OF THE STUDIES OF IRONS AND BROWN, IRONS, AND GUYTON AND WOODS, ON THE ETIOLOGY OF UVEAL DISEASE

Report	Syphilis percent	Tuberculosis percent	Focal Infection percent	Gonorrhea percent	Nongranulomatous Systemic Disease percent	Miscellaneous and Undetermined percent
Irons and Brown 1916 and 1923	19	4	72	—	—	5
Irons 1931	8.9(?)	15–56	24–64	—	—	—
Guyton and Woods 1940	10.5	49.7	26.1	4.6	5.9	3.2

lowing the injection of relatively small doses of these organisms, especially of streptococci. Multiple doses were more efficacious than single doses. Few eye lesions, however, resulted from artificially implanted foci of infection, and there was no higher incidence of iritis in animals having a concurrent arthritis than in those with no demonstrable involvement of the joints. Chojnacki[50] isolated streptococci cultured from apical abscess in 10 cases of iritis and 4 cases of axial optic neuritis, and inoculated these streptococci intravenously in rabbits. Twenty-four of 38 such experimental rabbits developed ocular inflammation. Other experimental studies on the direct relation of foci of infection to inflammatory ocular disease are along these same lines, dealing in the main with the elective affinity of organisms isolated from the primary foci for the eyes, and the experimental production of ocular lesions in animals by the intravenous injection of such organisms.

It is obvious that while there is clinical and experimental evidence supporting the hypothesis that ocular disease may be caused by bacteria carried to the eye from remote foci of infection, such evidence is largely suggestive and circumstantial. It consists, first, in the indisputable fact that many cases of ocular disease are encountered in which there is no demonstrable systemic cause other than the presence of remote foci of infection; second, there are countless instances in which dramatic and prompt healing of the ocular disease has followed eradication of the primary focus. Third, sudden transient exacerbations are occasionally observed after extraction of teeth or removal of tonsils, and it is argued that these indicate a relationship between ocular disease and the focus of infection; fourth, there is some evidence that blood-stream infection may be present in the early stages of the ocular disease; fifth, in experimental animals an iritis may be produced by the intravenous injection of organisms, especially streptococci; and, finally, there is some far-from-convincing evidence that some organisms may have a special predilection for ocular tissue.

Against each of these points, however, grave objection may be raised. Against the first point, that many cases of uveal disease are encountered for which no systemic cause can be found other than foci of infection, may be advanced the following fact: Foci of infection are present in many otherwise healthy people, and, despite various reports to the contrary, they do not appear more frequently in patients with uveitis than in patients without uveitis. Hughes[51] studied the incidence of dental infection and sinus infection in a series of patients, most of whom had uncomplicated cataracts and none of whom had any evidence of uveal disease. This study was made at the Wilmer Institute under exactly the same conditions which governed the study made by Guyton and Woods in patients who had uveitis. Guyton and Woods correlated these figures statistically to conform with the age distribution in decades for the patients with uveitis and compared the incidence of

TABLE 6

INCIDENCE OF FOCI OF INFECTION IN 523 PATIENTS WITH UVEITIS AND 507 CATARACT PATIENTS WITHOUT UVEITIS (CORRECTED STATISTICALLY TO CONFORM WITH AGE DISTRIBUTION BY DECADES)

Type of Patient	No. of Patients	Foci of Infection	
		Dental Infection percent	Sinus Infection percent
Patients with uveitis	523	27.1	12.4
Patients with cataract	507	25.8	13.0

such foci of infection in the two groups. This comparison is shown in table 6. Thus in the 523 patients with uveitis the incidence of dental infections and sinus infections was, respectively, 27.1 percent and 12.4 percent, and in the 507 patients with cataract the incidences were 25.8 percent and 13 percent. On the basis of these figures it is manifestly absurd to advance the argument that the mere finding of dental and upper-respiratory-tract infection in patients with uveitis is evidence of a causal relationship between the two. The fact that no other etiologic factor can be found is at best only negative evidence.

In recent years American ophthalmologists have realized more and more the importance of tuberculosis and brucellosis as causes of ocular disease, and the difficulty in reaching an accurate diagnosis in either of these is well known. Many of the cases of uveal disease formerly attributed to focal infection are probably instances of ocular tuberculosis, and the presence of infected tonsils, sinusitis, or periapically infected teeth only incidental and inconsequential findings. The following case history is typically in point.

M. L., aged 34 years, was examined on March 3, 1930, and was found to have an inactive uveitis of the right eye and phthisis bulbi of the left eye. There was a history of bilateral uveitis two years previously. Survey disclosed latent syphilis, chronic sinusitis, chronic tonsillitis, carious teeth with gingivitis, bronchitis, and subacute pelvic inflammatory disease. A radiograph of the chest showed a nontuberculous infiltration of lungs. The patient was sensitive only to 0.1 mg. of tuberculin. On May 25, 1932, the left eye was removed as a lost sightless eye. Histologic examination showed the classical picture of tuberculous cyclitis.

Second, the argument that dramatic cures so often follow eradication of the foci of infection may be countered by the argument that such spontaneous cures frequently occur if nothing is done, and likewise in a great number of instances removal of all possible foci of infection leaves the unfortunate patient no better off as concerns his eyes than he was in the beginning. Stripped of tonsils and teeth, often the victim of colonic irrigations, abdominal and genitourinary operations, the patient may finally be reduced to only those organs necessary for existence, while all the time his ocular disease progresses remorselessly to blindness. That the incidence of recovery or improvement in ocular disease after eradication of foci of infection is not that indicated in many enthusiastic reports is evidenced from the report of Mata López.[52] In a series of carefully studied inflammatory eye diseases believed due to dental infection, he found that extraction of the infected teeth and cleaning up of the oral infection resulted in healing of the eyes in 12.5 percent. Further, the improvement in ocular lesions after eradication of the focus of infection may be relief from absorption of nonspecific material from the infected focus and this improvement may be only temporary. Thus vom Hofe[53] reported 13 cases of inflammatory ocular disease, all of which cleared on removal of infected tonsils, or the cleaning-up of oral sepsis. In 10 of these, however, the improvement was only temporary, the eyes relapsing to their former condition. An essentially similar finding was reported by Guyton and Woods. In their series of patients, in whom the uveitis appeared causally related to foci of infection, the foci were totally removed in 42 patients, partially removed in 11 patients, and not removed at all in 21 patients. The incidences of recurrence in the three groups, over a period of observation from 3.8 to 4.2 years were, respectively, 33, 36, and 29 percent. As early as 1933 Lourie,[54] after reviewing the evidence to date, concluded

that neither the present state of scientific knowledge nor clinical observations justified the operative removal of the suspected foci for the purpose of alleviating ocular infections.

Third, the exacerbations of the ocular disease occasionally observed immediately following the eradication of a focus of infection are explained by advocates of the focal-infection theory on the grounds of an activation of the eye lesion by the transient bacillemia which so often follows operative interference on an infected focus. This is of course possible, but it cannot be proved. It may be better explained either as a simple Shwartzman phenomenon, the lighting-up of an inflammatory focus through absorption of nonspecific protein, or on the basis of allergic shock to specifically sensitized tissue.

Fourth, the finding of a transient bacillemia in the early stages of an inflammatory uveal disease, while it does occur, is an extremely infrequent occurrence, and Kolmer[55] has emphasized how rarely positive cultures are obtained from the blood stream and the aqueous in cases of acute iritis, and, further, that the transient bacteremias which occur in infection of the teeth, tonsils, and other structures, are quickly controlled by the bacteriostatic action of the blood. Further, it is remarkable, when one considers the large number of cases of streptococcus and staphylococcus septicemia, that secondary infection of the uveal tract so seldom occurs. Fifth, while it is well known that iritis and uveal-tract infections may follow the intravenous injection of bacteria in animals, the claim that certain strains of organisms have a selective affinity for ocular tissue is so flimsy that it has no place in court. Every investigator who has injected animals intravenously with living bacteria is quite well aware that occasionally, sometimes frequently, metastatic lesions occur in the eye. Primarily these lesions are purulent or give the picture of an enophthalmitis, and only occasionally simulate or suggest the clinical lesions of the iris and uveal tract attributed to focal infection. While lesions do occur in the eye, they likewise occur with equal frequency in diverse organs, the liver, kidneys, spleen, and others. The figures cited to indicate oculotropism are totally unconvincing. It is of course conceded that bacteria do develop a certain environmental preference, but there is vastly more experimental evidence against oculotropism and the elective affinity of bacteria than there is for these suppositions. Thus Bellavia[56] injected rabbits with cultures of organisms obtained from foci of infection in patients with ocular disease. Whereas he observed slight ocular changes of short duration, it was not possible to reproduce the ocular affection of the donors in the experimental rabbits. Giani[57] studied the localization of various organisms in both normal and traumatized eyes after intravenous inoculation. Peculiarly enough, he found the highest

TABLE 7

EFFECT OF REMOVAL OF FOCI OF INFECTION ON RECURRENCES OF UVEITIS

Treatment of Foci of Infection	No. of Patients	Average Period Followed years	Previous Attacks percent	Recurrences percent
Totally removed	42	4.5	55	33
Partially removed	11	3.8	73	36
Not removed	21	4.2	67	29

incidence of ocular localization occurred with B. prodigiosus and a comparative low incidence of localization with various streptococci. There was no difference in localization in the normal and untraumatized eyes. Cusumano[58] passed organisms, streptococci and staphylococci, from eye to eye of different series of experimental rabbits, in the hope of developing an elective affinity of the organisms for ocular tissue. When these organisms were later injected intravenously, lesions occurred throughout the body, in the eye, liver, joints, kidneys, and spleen, a slight preference for the eye being shown by streptococci cultivated in brain broth. Nothing suggesting specific organotropism was found, his results being in disagreement with those of Rosenow and his followers.

Scientific proof that ocular disease of unclear etiology may be caused by bacterial metastases from remote foci of infection, the crux of the focal-infection theory, appears woefully absent, and an impartial judge is forced to agree with Verhoeff that believers in such direct bacterial metastasis must base their belief on faith alone. There is, however, a strong possibility that foci of infection may be related to remote disease, not by direct bacterial metastasis but through sensitization and intoxication of the secondarily affected tissues by bacterial proteins, or secondary metastatic products absorbed from a primary focus. This possibility has been the subject of much interesting and productive investigation.

As early as 1902 Menzer[59] observed that immunity might play a very important part in the production of certain arthritic conditions. In 1916 Billings mentioned the possible part anaphylaxis, or allergy, might play in the production of secondary metastatic foci from the primary focus, but dismissed it as an idea for further investigation. In 1928 Holman expressed his belief that the fundamental basis of many rheumatic disturbances was a hypersensitiveness to various exciting causes and cited the work of Boots and Swift,[60] indicating that the arthritis of serum sickness was clearly an allergic phenomenon, and of Turnbull,[61] which indicated that in the absence of foci of infection food hypersensitiveness might be responsible for certain cases of arthritis. As early as 1914 Fuchs and Meller[62] produced an experimental iritis in animals by intraocular sensitization of eyes with human serum and intoxication by intravenous injection 35 days later, thus proving an allergic iritis to be a possible experimental entity. The evidence that secondary eye inflammation may be related to hypersensitivity from absorption of toxins or bacterial products from a focus of infection begins with the work of Swift, Derick, and Hitchcock[63] in 1928. These authors found that by proper inoculation with streptococci a specific bacterial hypersensitivity, quite like the tuberculin hypersensitivity in tuberculosis, could be induced in experimental animals, and that the eye participated in this hypersensitivity. Later contact of the sensitized eye with the specific bacterial antigen produced an inflammatory reaction. The ocular hypersensitivity was best induced by an implanted-agar focus kept infected with streptococci for many months. Studying the sensitivity thus induced they found a period of greatly increased sensitivity or hyperergy, when there occurred a maximum tissue response to a minimum stimulus. This reaction was further studied by Derick, Hitchcock, and Swift,[64] and by Schultz and Swift,[65] who showed that this state of hypersensitivity might be induced either by an infected-agar focus or repeated intracutaneous inoculations. Once induced it lasted at least up to the seventieth day, and there was no parallelism between the ocular and cutaneous sensitivity. Julianelle[66] studied

the question, using pneumococci, and showed that the nucleoprotein fraction of the bacterial body was responsible for this tissue hypersensitivity. Brown[67] varied this procedure somewhat by sensitizing the eyes by anterior-chamber injection of various proteins, bacterial toxins, and killed bacteria. After a proper rest period the intravenous injection of the specific antigens to which the eye had been sensitized produced a serous iritis with pericorneal injection and dilatation of the iridic vessels. After the first attack quieted, repeated intravenous injection of the antigen produced further exacerbations, with the appearance of exudates in the anterior chamber and posterior synechias. Brown called attention to the fact that the clinical picture of the iritis thus produced by allergic methods closely resembled the type of recurrent serous or plastic iritis observed clinically, and was quite different from the purulent iritis, panophthalmitis, or endophthalmitis usually produced by the intravenous injection of living organisms.

These various experimental procedures employed to produce an allergic iritis are all open to the criticism that either at sensitization or intoxication there was some traumatism of the eye. However, in 1936 MacLean[68] succeeded in producing an iritis by sensitization of the eye through repeated intracutaneous inoculations of living organisms and intoxication by intravenous injection of the organism, a procedure which involved no traumatism of the eyes.

It is apparent that a quite reasonable experimental basis exists for the supposition that primary foci of infection may be related to secondary ocular inflammation through a mechanism of sensitization and intoxication from the primary focus. Indeed, if such an allergic basis is assumed it is not necessary to postulate that the primary source of sensitization and intoxication be a clinically infected focus of infection. It is quite within the realms of reason that all mucous membranes and even cutaneous surfaces, whether clinically infected or not, may act as potential portals of entry for bacteria into the blood stream. Clinical support of this theory, is, however, still lacking, and the technical difficulties are so great that such evidence may be impossible to obtain. The chief of these difficulties is demonstrating a significant sensitivity to the products of ordinary pathogenic bacteria. Individuals are so constantly exposed to these organisms that more or less sensitivity is a routine finding. It is therefore impossible to attach much diagnostic significance to positive skin tests, or serologic reactions to common bacteria when autogenous organisms cultivated from a primary focus are used. It is likewise impossible at present to determine the local sensitivity of the diseased eye, which is after all the salient point. There is as yet no conclusive evidence that such findings as cutaneous reactivity or a high agglutinin titer against suspected organisms are of real diagnostic importance. All that can be said at this time is that experimental studies indicate that such an allergic mechanism for the production of ocular inflammation from a remote focus of infection is a possibility.

Should clinical ocular disease result from sensitization and intoxication of the eyes by material elaborated from a remote focus of infection, it would explain several of the clinical observations advanced as supporting evidence by the advocates of the focal-infection theory. The clinical improvement which so often follows eradication of the suspected focus might be due to the removal of the source of intoxication. The exacerbations that occasionally follow the operative removal of the focus might be due to the sudden

opening up of a large area for absorption of the responsible bacterial antigen. The exacerbations of the ocular disease that occasionally follow too large an injection of an autogenous vaccine might be a true focal reaction induced by an injection of antigen above the point of ocular reactivity. Not only would such an allergic mechanism explain the clinical observations that are supposed to indicate a relationship between ocular disease and a focus of infection, but it would also answer the various arguments against direct bacterial metastasis. Unfortunately, while there is a reasonable experimental basis for believing that such a mechanism may exist, there is no proof of such in patients, nor does such proof appear likely to be immediately forthcoming.

Thus stands the theory of focal infection today as regards ophthalmology. It still remains one of the tenets of faith for many, if not the majority of American ophthalmologists. It must be candidly admitted that practically all the actual evidence in favor of the theory as originally set forth and generally subscribed to, is totally clinical, largely suggestive, and circumstantial. If this theory continues to be accepted and followed in the clinical practice of ophthalmology, such acceptance and practice must be largely on faith. However, it is assumed that there may be a cause-and-effect relationship between a primary focus of infection and ocular disease through such a mechanism as sensitization and intoxication of the diseased eye by bacterial products absorbed from the focus of infection; a fair experimental basis can be advanced for such an assumption, although clinical evidence is lacking.

From the practical viewpoint the wisest course in the treatment and diagnosis of endogenous ocular disease is to continue the search for foci of infection. When such foci are found, if they are believed sufficiently severe or capable of impairing the general health of the patient, they should be removed either for their own sake or to improve the general health and resistance of the patient. If there is anything in the clinical picture to suggest a relationship of the diseased focus with the ocular inflammation, such as the outbreak of the ocular disease coincident with a lighting up of the primary focus, an undue sensitivity of the patient to organisms isolated from the primary focus, or a flare-up of the ocular inflammation after injection of a vaccine prepared from the primary focus, then operative eradication is indicated whether one believes that the ocular disease is caused by direct bacterial metastasis, by sensitization and intoxication by bacterial products, or by absorption of toxins from the primary focus. However, the routine removal of minor and symptomless foci of infection as a cure-all for endogenous ocular disease has no place in modern ophthalmology.

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OPHTHALMOSCOPIC OBSERVATION OF MICROFILARIAS IN THE VITREOUS OF PATIENTS INFECTED WITH ONCHOCERCIASIS

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Patients suffering from onchocerciasis frequently report as a subjective symptom the vision of tiny moving bodies of a vermiform shape and having great mobility. For this reason they have no hesitation in saying that they can see the parasites when they know that they are infected with this terrible disease. Several observers have confirmed that these moving bodies correspond to microfilarias and perhaps filarias of small dimensions, which are visible when they come near the surface of the retina, in the neighborhood of the macula.

In 1925, one of these patients after making a long trip from the onchocercosic zone of Guatemala arrived at the Ophthalmological Hospital of Our Lady of Light in Mexico, D.F., where he described in great detail the shape, size, and position of one of these bodies moving inside of his eye. Dr. Rafael Silva was able at the time to observe the parasite and identify it, finding a body about the size of three papillary diameters, very mobile, and possessing a great refringence, with golden reflections. The examination was made merely by illuminating the fundus of the eye with a flat mirror in the same way as in exploring the transparency of media. With the large Gullstrand ophthalmoscope Dr. Silva was able to observe the shadow projected by the filaria on the surface of the retina. From this fact and its great mobility, he concluded that the filaria was free in the vitreous. With red-free light the parasite had a silver reflection.

This discovery had the merit of proving that the ocular lesions observed in this disease are due to the presence of the parasites in the tissues of the eye and not, as asserted before, to the distant action of the toxins produced by the filarias and microfilarias contained in the cysts and cutaneous lesions. The latter were described first by Robles, Pacheco Luna, and Calderón of Guatemala, who also emphasized the frequency of the macroscopic lesions in the eyes, attributing them to the action of toxins.

Since then a new field has been opened to investigators and in this way Ochoterena in 1930 and Richard Strong in 1931 confirmed the presence of the parasite in pathologic sections of different tissues of the eye, such as the conjunctiva, cornea, choroid, and retina. Moreover, Strong found them in the fresh vitreous of eyes recently enucleated. Later, Torroella for the first time used the slitlamp in the study of the ocular lesions and discovered microfilarias, active and moving in the anterior chamber. Since then his method of exploration has been used by other investigators such as Müllens, Hissette, and others.

Biomicroscopy, performed with the corneal microscope, allows only the exploration of the cornea and the anterior chamber, but does not permit the observation of the posterior layers of the vitreous body, unless the Koeppe microscope with the special contact glass is applied. Unfortunately, biomicroscopy cannot be practiced except in well-equipped ophthalmologic centers, which have a trained staff; but even by this means the examination of the microfilarias is difficult. This is due in great part to the great refringence of the parasite and its extreme thinness, which makes it scarcely visible, in the same way that it is difficult to distinguish with the naked eye irregularities in the

density of glass, but nevertheless these may be the cause of the distortion of the images seen through it. On the other hand, the great mobility of the parasites, their scarcity in the anterior chamber, and the fatigue produced in the patient by this examination somehow limit the use of biomicroscopy. The observer should be warned that microfilarias are best seen with the low-power objective, which gives a larger field in length and depth. They can even be observed with a loupe, as they are of relatively large size, varying from 150 to 160 micras; that is, between 0.15 and 0.36 millimeters, or approximately one-sixth to one-third mm. With convenient illumination I have been able to make the observation with the loupe in the penumbra. In the same way it is possible to observe them with a six-magnifier loupe in a fresh or stained preparation.

Instead of the loupe, the electric ophthalmoscope can be used, placing in the aperture of the instrument a lens of from +20 to +40 or +50 diopters. This has the advantage of making the axis of vision coincide with the incidence of the pencil of light that illuminates the field to be observed. It also permits the study of the eye, layer by layer.

When the microfilarias are in the vitreous I have found that ophthalmoscopy is the best means of detecting them and following their movements. With +20 to +40 diopter lens, the refraction of this lens added to that furnished by the dioptric system of the eye makes it possible to observe the parasites in very fine detail. This method of exploration being commonly used in practice, it is strange that it had not heretofore been used for this purpose. Perhaps it has been thought that the haziness of the cornea induced by the punctate keratitis, so common in this disease, or exudates in the pupil after iritis may prevent its use, but the corneal involvement being located first in the periphery and appearing late in the course of the disease, there is no difficulty in observing the vitreous with the ophthalmoscope in the majority of patients.

Microfilarias in the vitreous seen with the ophthalmoscope appear different from those observed in the anterior chamber with the use of the corneal microscope. Whereas with the latter they are seen in direct light and appear white, very fine, and with golden reflections, with the ophthalmoscope they are observed in transmitted light and appear as black, very thin filaments animated by quick, spontaneous movements readily visible on the reddish background. When the microfilarias are numerous, they acquire a fantastic aspect by their form and movement reminiscent of mosquito larvas in the water (this same comparison is made by some patients who observe in themselves the movement of the parasites), and only when they come very close to the posterior part of the lens do they take on the characteristic refringence and golden reflection. In some filarias there is the curious phenomenon that one portion may be refringent and the other black. The apparent diameter in which the parasite can be seen with a 50D. positive lens in the ophthalmoscope is about 4 mm. long, that is to say about half that in the anterior chamber, when examined with the objective A. 2 and ocular 5.5 of the corneal microscope.

The study of microfilarias by means of the ophthalmoscope is easy and can be made better with the pupil dilated. It has the advantage that it can be made anywhere with a simple instrument, by the general practitioner as well as the specialist. In addition to the facility with which the microfilarias may be observed, ophthalmoscopy will permit a better study of their abundance and their relations to the ocular lesions they provoke.

In a small group of onchocercosic pa-

tients I have been able to observe that the microfilarias have markedly negative phototactism. This is contrary to the accepted idea, but my contention is supported by the following data:

1. The microfilarias become more apparent in the anterior chamber at night than in the day time.

2. Upon examination with the ophthalmoscope they are found in greater numbers in the periphery of the pupillary field and in fewer inside it.

3. At the beginning of the examination, especially if the patient has stayed in a dark room, a number of microfilarias are frequently found in the center of the pupillary field, but a few minutes later they have fled toward the periphery.

Up to this time I have studied 11 cases of onchocerciasis (of which 7 had been sent me through the courtesy of the Institute of Health and Tropical Diseases) and in all of them I have been able to find microfilarias. The case histories are summarized in the accompanying table. They show the possibility of finding microfilarias with the ophthalmoscope in patients in whose anterior chamber no parasites were found, in those who did not show macroscopic lesions, and even in those who had negative biopsy specimens.

TABLE 1

SUMMARY OF THE CLINICAL HISTORY OF 11 ONCHOCERCOSIC PATIENTS

Case Number		Age	Sex	Onchocercosic Antecedents	No. of Onchocercosic Nodules	Cutaneous Lesions	Biopsy Specimens of the Skin	Ocular Involvement without Apparent Lesions	Entoptic Phenomena	Macroscopic Ocular Lesions	Microfilarias in the Ant. Chamb. by Biomicroscopy	Microfilarias in the Vitreous by Ophthalmoscopy
1	R. C. O.	11	M	yes	8	yes	yes	hyperemia, photophobia	yes	no	yes	yes
2	N. C. O.	10	F	yes	3	yes	yes	hyperemia, photophobia	no	no	yes	yes
3	C. C. G.	24	F	yes	9	yes	yes	hyperemia, photophobia	no	no	yes	yes
4	G. G. C.	33	M	yes	4	yes	yes	hyperemia, photophobia	no	punctate keratitis	no	yes
5	V. Z. B.	25	M	yes	10	yes	yes	hyperemia, photophobia	yes	keratitis, atrophy of the iris	yes	yes
6	A. M. R.	26	M	yes	8	yes	yes	hyperemia, photophobia	yes	punctate keratitis	yes	yes
7	E. S. Z.	30	F	yes	8	yes	yes	hyperemia, photophobia	yes	no	yes	yes
8	B. S.	60	M	yes	4	yes	yes	hyperemia photophobia	yes	keratitis, cataract in left eye	no	yes
9	T. C. G.	39	M	yes	9	yes	yes	hyperemia, photophobia	yes	keratitis, perikeratitic growth	yes	yes
10	A. S.	43	M	yes	2	yes	yes	hyperemia, photophobia	yes	perikeratitic growth	no	yes
11	V. G.	34	M	yes	2	no	yes	hyperemia, photophobia	no	no	no	yes

CONCLUSIONS

1. It is possible to observe the microfilarias in the vitreous with the electric direct-image ophthalmoscope. 2. The

microfilarias seem to be more abundant in the vitreous than in the anterior chamber. 3. Observation of the parasite is easier with the ophthalmoscope than with the slitlamp microscope. It may be found with the ophthalmoscope in patients in whom nothing is seen in the anterior chamber and even in those showing negative biopsy specimens of the skin. 4. The examination is so easy that it can be done by general practitioners and visiting nurses connected with Sanitary Missions in the infected areas. 5. The observation of microfilarias in the vitreous can be made at early periods in the development of the disease.

I wish to express my gratitude to Dr. Miguel Bustamante, the present Director of the Institute of Health and Tropical Diseases, and Dr. Manuel Martinez Baez, his predecessor, as well as Drs. Luis Mazzotti, Javier López Portillo, and other members of this Institute for their valuable coöperation.

EYE SURGERY IN WAR TIME*

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Ophthalmology is not essentially different in war and in peace time and the change from the one to the other should prove easy to anyone acquainted with the basic principles of general war surgery. These principles have, of course, evolved, but in their present status they can be defined as follows:

War wounds almost always contain foreign bodies, not only the missile, but also various others; for example, earth, gravel, pieces of wood, buttons and leather from the soldiers' equipment, and especially fragments of clothing. War wounds are a combination of penetrating and contusioned wounds; an irregular piece of metal impacted at high speed has crushed its way through the skin, and the tissues along the path of the projectile, particularly the muscular tissues, are damaged and will necrose. These damaged muscular fibers are a perfect medium for bacterial growth and a source of autointoxication through proteolytic distintegration.

War wounds are infected, and usually severely infected. Contamination is due mostly to the imbedded foreign bodies, especially bits of clothing, and infection is facilitated by the disintegrating muscular tissue. During an initial period of approximately six hours, the germs are present, but there is no bacterial growth. This is the stage of contamination as distinct from infection. After 6 hours, and up to 36 or 48 hours, the infection will remain limited to the path of the projectile and to the surrounding crushed tissues. Later the infection spreads and is more difficult to control. Sulfonamides, if applied locally at the time of the first dressing, have a marked bacteriostatic effect and the safe period is considerably lengthened, up to two or three days instead of six to eight hours.[2]

Since these are now well-established

* This paper is based principally on my personal experience and that of my friends in France during 1939-40. I have also made use of an excellent book by Duverger and Velter "Ophtalmologie de guerre,"[1] which was published in 1919, but is still well worth reading. As my experience with ophthalmic war surgery came to an end or was momentarily interrupted in June, 1940, I have consulted the Bulletin of War Medicine published by H. M. Stationery Office in London since September, 1940, and War Medicine published by the American Medical Association since January, 1941. Both contain valuable information on work done since 1940.

facts, wounded soldiers should be operated upon as soon as possible. The wounds should be opened, explored, and cleaned. This means that all foreign bodies should be removed and also that all tissues severely damaged and not destined to survive should be resected. If the wound was operated upon early and all other conditions were satisfactory, in particular if all foreign bodies and crushed tissues were removed, and if the soldier does not have to be evacuated at once but can be watched, a primary closure is possible. If successful this permits rapid healing and better functional results, but if the technique was imperfect, and especially if the patient is not watched carefully during the next few days, very serious infection can develop, particularly gas gangrene.† A delayed suture is less dangerous; the wound is drained and left open under daily bacteriologic control, and sutured only when there are no streptococci, no Cl. welchii, and only few other germs. In many cases the wound is drained and left open to heal by granulation and second intention. Antiseptics should be used sparingly and only nonirritating ones; Dakin's solution, for example. But sulfonamides now tend to replace all other medications in the control of infection.

Such are the general principles of war surgery, but, compared to other wounds, those of the eye and orbit differ in certain ways and these general rules must be qualified when applied to ophthalmic surgery. In many respects wounds of the eyelids and orbit are favored as far as infection is concerned. Contamination is usually less severe since pieces of clothing are rarely imbedded and the wounds are less often soiled with earth. There are also no large muscles destined to necrose, and, above all, the blood supply in the face being exceptionally good, the defense of the tissues against both necrosis and infection is excellent. Extensive wound excisions are unnecessary, and if the foreign body has been removed, the wound cleaned, and the most hopelessly damaged tissues resected, infection does not often develop or is easily controlled. Primary closure, therefore, is more often possible, and in any case drains are rapidly shortened and removed, especially if sulfonamides were implanted. This is important, for cosmetic results are better when wounds are not left open and drained a long time.

The eyeball shows less resistance to infection, and this is unfortunate, since first-intention healing is essential if any vision is to be preserved. One must, therefore, always attempt a primary suture of the cornea and sclera if the wound is not too severe and there is some hope of obtaining even limited vision. If no primary suture is possible it is useless to let the eye remain, and one must think of obtaining as good a prothesis as possible in the future.

If the eyeball was sutured there is danger of a possible sympathetic ophthalmitis, and it must be carefully watched. During World War I the fear of this complication was so great that it resulted in the performance of an unnecessary number of early enucleations. Sympathetic ophthalmitis is not very frequent (1/3,000 in World War I according to Morax[1]) and in any case it never occurs in the second eye if the injured eye is removed within 15 days. An enucleation is, therefore, never urgent when one first sees the wounded soldier and one is entitled to try conservative surgery. The eye is then watched carefully and if it proves infected or doubtful it must be enucleated within 15 days, or at any later

† This danger is so serious that surgeons not familiar with war surgery had better resort to a delayed suture.

date if infectious symptoms appear.

The danger of sympathetic ophthalmitis is particularly great if the ciliary body was injured, if fragments of uvea were herniated or remained incarcerated, and especially if all foreign bodies were not removed. Every effort should, therefore, be made to remove all intraocular foreign bodies. Some may seem to be tolerated for months and then suddenly cause serious trouble. If imbedded in the cornea or in the orbital tissues they can sometimes be allowed to remain.

If the eyeball was very severely damaged and one does not decide even on tentative conservative surgery, one must at least try to obtain the best cosmetic appearance. If only the anterior segment was injured, it is not necessary to enucleate, and it is better only to resect the anterior segment. If the vitreous is normal, it can be left in place; otherwise it is removed and a glass implant can be inserted in the sclera after careful currettement of the retina and uvea. Many surgeons may not approve of this procedure but I think it is without danger and should be tried if the sclera is scraped clean with great care and no fragments of uvea are retained. It will prevent sympathetic uveitis of the injured eye and, therefore, do away with any menace to the other. Of course, this does not apply to cases in which conservative surgery was attempted and failed and where infectious symptoms make one decide that the injured eye is dangerous and should be removed. In such a case one should, of course, perform an enucleation.

For a good prothesis it is also important that there should be no prolonged infection of the conjunctiva as this tends to produce adhesions and more or less complete symblepharon. It is, therefore, desirable not to drain the orbit through the conjunctiva. One must always try to suture the conjunctiva after removing the eyeball, and if the orbital tissues must be drained it is often better to do it through a separate incision of the skin.

Sulfonamides in war surgery

The "sulfa drugs" have taken such an important place in war surgery that they tend to replace all other antiseptics and deserve more than a cursory reference. My personal experience having unfortunately ended in July, 1940, I have used only sulfanilamide and sulfapyridine and have not tried the effect of sulfathiazole and sulfadiazine. There does not seem to be a consensus of opinion as to which of these drugs is best. Many claim that sulfanilamide is still the most powerful, others give a preference to sulfadiazine as less toxic and more active. Some advise using a mixture of two parts sulfanilamide and one part sulfadiazine. Sulfapyridine has been used principally by mouth.* Some claim sulfathiazole to be the best local treatment for gas gangrene.[3]

Inasmuch as I have no personal opinion and believe that time and experience will probably settle this question, I shall speak of sulfanilamide as a representative of the "sulfa-drug" group and in no way to the exclusion of the others.

Sulfanilamide is not really antiseptic and does not seem to destroy the germs so well as do many other drugs, but it has a powerful bacteriostatic and, therefore, preventive action. It should be used as early as possible and in fairly large doses to prevent infection from developing. Locally it should be implanted in the wound. Sulfanilamide powder (sterilized in dry heat at 120°C.) is sprinkled freely in the wound. It is also convenient to insert sulfanilamide tablets in the deep parts of the wound and to crush them with a

* When short of sulfanilamide I have used sulfapyridine locally with good results.

hemostatic forceps. Three to five grams is usually enough for the orbit, but in large wounds much more can be inserted, and in general surgery 10 to 20 grams is often used. Locally implanted sulfanilamide is gradually absorbed and often completely eliminated after two or three days. It is, therefore, desirable to give sulfanilamide immediately by mouth. For rapid absorption one or two grams is given in a hot 1-percent citric-acid solution sweetened with glucose. Afterward 0.5 gram is given every four hours during the first day. During the next few days the dosage can be reduced: 1 gram every eight hours for 6 to 10 days.*

If infection has already been established when the wounded soldier is first seen, much larger doses should be administered: four grams at once and one gram every four hours during the first 24 hours, gradually reducing to 0.5 gram every four hours by the end of the week. Sulfanilamide need not be given for more than 10 days.

Sulfanilamide in 3-percent solution can also be used to wash out the wound when the dressing is changed, and 3- to 5-percent sulfanilamide ointment can be placed between the eyelids in cases of wounds of the anterior segment, or smeared over the surface of the eyelid or orbital wound, for it will keep the skin clean and eventually facilitate the removal of the dressing.

Injuries of the eyelids

The blood supply of the eyelids is exceptionally good. The defense of the tissues against infection is, therefore, excellent, and extensive wound excision is not necessary. Proper alignment on resuturing is essential. Sutures should be removed early, from the second or third day on.

After cleaning the wound and resecting very sparingly only the hopelessly damaged tissues, one should piece the eyelid together and suture at once. This is often easier than at first it might appear to be, for the skin is very elastic. Some sliding can be done after undercutting. Every effort should be made to repair at least the margin of the eyelid, so as to avoid a V-shaped notch. A suture in two planes is usually best for this purpose.

If the eyelid and ocular conjunctiva are both injured, one must at least try to repair one of the two so as to avoid having raw surfaces in contact (symblepharon).

If the canaliculus is divided, and the wound is clean, an attempt should be made to repair it. A direct suture is not possible, but one can often probe both parts with a no. 3 Bowman, which is left in place for a week or so, the surrounding tissues being approximated with care.[4] Another technique uses a silk suture with a needle on each end; one needle is passed down the lumen of the lateral cut half of the canaliculus, coming out through the punctum lacrimale. The other needle is entered in the medial cut end of the canaliculus, passed a little way along the lumen, and then turned forward so that the point is brought out on the skin of the face. The sutures are then tightened.[5]

Numerous foreign bodies of the cornea

These are frequently encountered; for instance, metal, sand, gunpowder. The eye should be flushed with a sterile warm 14/1,000 saline solution, and many foreign bodies come out at once. Of those that remain imbedded the more superficial can be removed with a spud or a narrow cataract knife, but it is better not to probe into the deep layers of the cornea to remove the others. Some will come to the surface within the next few days, others

* Sodium bicarbonate should be given at the same time.

will remain and give no discomfort. If any must eventually be removed, it is advisable to do this later, when more sterile conditions can be obtained, and only a few at a time. Sulfanilamide ointment is inserted between the eyelids, and the eye is patched.

Wounds of the anterior segment of the eye

These wounds are similar to those seen in industrial casualties.

(a) If the injury is very serious and there, is no hope of restoring even a limited vision, the anterior segment should be resected. The vitreous can be left in place if found normal; otherwise, it is removed, and a glass implant is put into the sclera after the retina and uvea have been carefully curetted.

(b) If possible one should attempt to retain the eye, especially if both are injured, since it is difficult to tell which will eventually be the better one. Conservative surgery is often possible, particularly if the wound is fairly clean and all foreign bodies can be removed.* Incarcerated fragments of iris should, of course, be resected. If the lens was injured it is better to remove at once as much as possible of the cataractous lens matter. A corneal suture is sometimes necessary for the approximation of the edges of the wound. The wound should in any case be covered by sliding a conjunctival flap. A complete conjunctival covering of the cornea is often advisable. Sulfanilamide ointment is applied.

In conservative surgery the eye should, of course, be very carefully watched and should be enucleated if after 10 to 12 days it remains inflamed, painful, soft, shows K.P.'s, or any other symptoms suggesting possible sympathetic ophthalmitis.

* Conservative surgery is rarely advisable when the ciliary body is injured.

Wound of the posterior half of the eye

This is a serious type of injury. It may sometimes at first be overlooked if a small piece of metal has entered through the nose, antrum, or the lateral wall of the orbit and there is no evidence of a wound in the anterior segment. If the vitreous is full of blood, the fundus cannot be observed and one may think there was only a contusion of the eyeball. Certain signs, however, point to a penetrating wound: Marked hypotonia, increased depth of the anterior chamber, chemosis due to loss of vitreous. An X-ray examination is, of course, particularly useful in these cases. If a foreign body is seen it should be removed, preferably through the entrance wound. In some cases, however, it is easier to make the extraction through a separate scleral incision or sometimes even through the anterior chamber. If the foreign body is nonmagnetic it is usually a piece of machine gun or rifle bullet (lead and alloy) since wood, earth, and gravel are not so penetrating and are more often found in the anterior segment. Every effort should be made to remove rapidly all foreign bodies, magnetic or nonmagnetic, as they are very rarely tolerated. If they are nonmagnetic a careful X-ray localization is essential, and some can even be removed under fluoroscopic control. After suturing the sclera it is well to make a few cauterizations around the wound in order to prevent a detachment of the retina.

The prognosis is favorable only in cases of small foreign bodies easily removed. In most others it is bad because of the likelihood of infection of the vitreous, proliferating retinitis, detachment of the retina, and other complications. Blood may persist for a long time in the vitreous and become absorbed only very slowly.

Complete destruction of the eyeball

This is a frequent type of injury. All remaining fragments of sclera should be removed after they are carefully separated from the conjunctiva and the muscles. This procedure is made easier by picking up the remaining pieces on a suture. The conjunctiva is then closed with a purse-string suture to prevent secondary infection of the orbit, symblepharon, and difficult prothesis in the future.

Wounds of the orbit

(a) An orbital wound usually accompanies the preceding type of injury (destruction of the eyeball). In such cases, after resecting the remaining fragments of sclera, one must remove all intraorbital foreign bodies, if possible after X-ray localization. The large metallic ones are often felt with the finger. Smaller ones are sometimes difficult to find, even if magnetic, since the magnet is less effective than when the foreign body is in the eyeball. There is sometimes earth, sand, or wood in the orbit. Irrigation with a warm saline solution is always very helpful. It cleans, removes blood clots and some of the foreign bodies, and usually stops the bleeding. Hemostasis rarely calls for ligatures. When the orbital tissues have been cleaned as well as possible sulfanilamide powder should be freely implanted.

The conjunctiva should now be closed with a purse-string suture and the orbit drained if necessary through a separate incision in the skin near the outer and lower orbital margins. A bundle of silkworm gut or a strip of rubber sheet is usually better than a rubber tube. If the orbital tissues were drained and no sulfanilamide was used, Dakin's solution is indicated.

(b) If the eye is uninjured, the orbit should be explored through an external orbitotomy or a Krönlein operation. A clear-field operation is improbable, for blood usually fills the orbit and makes it difficult to tell the structures apart. A warm saline irrigation is helpful and will sometimes dislodge the foreign body together with the clots. Otherwise one must use one's judgment in looking for the foreign body so as to do no more damage than is absolutely necessary.

Here again large foreign bodies are usually easy to find, and smaller ones had sometimes better be let alone and removed later, if necessary. The good resistance of orbital tissues to infection makes this procedure possible here when it would be highly dangerous in other parts of the body. Sulfanilamide should of course be used freely and, especially if all foreign bodies were not removed, the wound should not be completely sutured but drained for a few days.

Fracture of the walls of the orbit

(a) *Lateral wall.* All fragments of bone still adherent to the periosteum should not be removed but replaced and pieced together with care. Wiring is not advisable.

(b) *Lower wall.* The antrum is washed out, and this removes the blood clots that are usually present. The foreign body should be removed if easily found. If it is incarcerated in the antrum it is better to let it alone and remove it through the nose in a later operation.

It is desirable and sometimes possible to elevate the floor of the orbit and replace it in its normal position.

If possible one should not drain through the orbit but through the antrum and nose. Crystalline sulfanilamide should be implanted in the wound and sprayed into the antrum.

The coöperation of an otorhinolaryngologist or of a maxillofacial surgeon is advisable.

(c) *Medial wall.* Emphysema is usual in fractures of the medial wall. Indications for treatment are similar to those given for injuries of the lower wall.

(d) *Upper wall.* If there is only a fissure of the roof, one may "wait and see," but if there is a fracture there is usually an injury of the dura mater and of the brain. The coöperation of a neurosurgeon is advisable.

Contusion of the eyeball

All symptoms are very much like those in civilian practice and usually require no immediate surgical treatment.

Iris: radiating lacerations, iridodialysis, hyphema.

Lens: dislocation, cataract.

Fundus: localized edema of the macula, intraocular hemorrhages, choroidal ruptures, detachment of the retina.

In blunt injuries the sclera is sometimes ruptured. Such ruptures are usually concentric to the limbus and about 3 mm. from it. The lens is often dislocated and sometimes extrudes under the conjunctiva. It should then be removed and in all cases the sclera must be sutured.

Commotio of the eyeball

(a) *In severe blast.* Intraocular hemorrhage and intraorbital hemorrhage with immediate loss of vision and late optic atrophy may occur. These hemorrhages are probably due to a sudden compression of the thorax and increased venous pressure. Complete rupture of the eyeball has also been reported.

(b) *In gunshot wounds of the face.* Even without a direct injury of the eye, the retina and choroid, especially in the macula, can show indirect traumatic symptoms. Later these can take on an appearance similar to that of infectious chorioretinitis (atrophy and pigment migration). These lesions by concussion are usually observed in cases of perforating wounds of the facial bony structures (F. Lagrange[5a]).

Burns of the eyelids and eyeballs

These are fairly frequent, particularly in the Navy, Air Force, and armored divisions.

(a) *Burns of the eyeball.* The eye should be flushed with warm sterile saline solution (14/1,000) and sulfanilamide ointment applied. The use of cocaine should be avoided.

(b) *Burns of the eyelids.* It is now recognized that tannic acid should not be applied to the eyelids and the face.

It must be understood that the more modern treatment of wounds has two purposes; namely to coagulate the surface of the wound so as to prevent loss of plasma and at the same time avoid infection. The first is not important in the eyelids, as the burned surface is too small to allow any important loss of fluid. The second aim, the prevention of infection, is, on the contrary, essential, so as to avoid unnecessary sloughing, retraction, and eventual ectropion with exposure of the eye. The stress is, therefore, on asepsis more than on coagulation. The burned surface should first be thoroughly cleansed with warm saline solution, the surrounding skin with soap. Blisters should be opened, loose epidermis removed. After this a dressing is applied that will keep the burned area clean and that upon removal will not be destructive of the newly formed epithelium. I have found "Tulle gras"* convenient for this, as it is slightly antiseptic, lets out the discharge through its open mesh, and can be left on when the dressing is changed. Different salves can also be applied 1- or 2-percent gentian violet jelly,

* Close-mesh curtain net cut in small squares and strips and impregnated with castor oil 60 parts, beeswax 10 parts, Peruvian balsam 1 part. This is sterilized in an autoclave at 120°C.

3- to 5-percent sulfadiazine or sulfanilamide salve. In Germany cod-liver oil is often used.

A slight amount of coagulation is preferred by others. I have personally had good results by painting the burned surface several times with a 2-percent aqueous solution of mercurochrome. Sulfadiazine 3 percent sprayed repeatedly has also been used. In Great Britain many have advised the following procedure: The burned surface is painted with a 1-percent aqueous solution of gentian violet; 10 minutes later it is painted with 10-percent silver nitrate; then again two or three times at 15-minute intervals with the 1-percent gentian violet.[6, 7] Others have advocated spraying "triple dye": 2-percent gentian violet, 1-percent brilliant green, and 0.1-percent neutral acriflavin.[8]

It is in any case essential to avoid secondary infection of the burned surface when the dressing is renewed.

In third-degree burns early skin grafting is a good procedure.

Gas casualties*

(a) *Lacrimatory, sternutatory, and lung-irritating gases.* The eyes are only slightly irritated and all symptoms subside rapidly. No treatment is necessary. The eyes can be flushed with a 14/1,000 sterile saline solution.

(b) *Vesicant gases (mustard gas, lewisite).* Mustard gas is an oily liquid (dichlorethyl sulfide) giving out vesicant vapors.

(1) In most cases the eyes are affected by the vapors and ocular symptoms are not severe. For four or five hours there are no symptoms; then itching appears with gradually increasing irritation, photophobia, and lacrimation. The exposed parts of the conjunctiva are red and there is slight chemosis. The next morning there is marked edema of the eyelids; photophobia and tearing are marked. Even in the absence of any treatment all symptoms disappear in a week or two. No antiseptics should be used, no cocaine, and no ointments. Mustard gas being incorporated in the latter, this delays its elimination. The eyes should be washed out with alkaline solutions (sodium bicarbonate, 2 to 5 percent), or oxidizing solutions (pertassium permanganate, from 1/5,000 to 1/10,000).

Hypertonic solutions have also been advocated on the grounds that they quicken the elimination. Here are two that have been tried successfully:

Saturated aqueous solution of sodium sulphate	800
Simple syrup	200
Magnesium sulphate	40
Simple syrup	50
Water	150

All these solutions must be sterile and used warm.

(2) In some instances there has been direct contact of the eyelids or eyes with the mustard-gas oil. This can happen either if the soldier was near enough to the exploding shell to be splashed or if he rubbed his eyes with soiled fingers. In this case symptoms are almost immediate and very much more severe, often leading to corneal ulcers. These are apt to recur repeatedly. The treatment is the same but the prognosis less favorable.

(3) Lewisite was about to be used when the last war ended in November, 1918. We, therefore, have no experience with its action under military conditions. From experimental work on animals and accidents to workmen in the course of production, it is probable that its effect is similar to that of mustard gas but more immediate and more marked. The treatment is probably the same.

Radiography

The removal of foreign bodies is

* This only refers to my experience with chemical warfare during World War I. Although new gases are probably ready, to my knowledge none have been employed up to now.

greatly facilitated by a careful X-ray localization. Of the numerous existing techniques I have found the following ones most useful in war surgery because of their accuracy and simplicity.

(1) Comberg's technique with a contact glass bearing four lead marks showing the position of the limbus.

(2) Vogt's technique of boneless radiography on dental films will show even very small foreign bodies in the anterior part of the eye. About one-half of the eyeball can be made visible on the film if 5 to 10 c.c. of normal saline solution are injected behind the eye.

(3) If no Comberg contact glass is available, four very small buckshot split in two with a knife can be attached to a silk suture and fixed at the limbus (E. Velter). It is also possible to obtain an emergency contact glass by cutting off the end of a test tube and marking it in four places with red lead (M. A. Dollfus).

(4) Operating under fluoroscopic control is sometimes resorted to, especially for nonmagnetic metal.

Magnet

For military use it is well to have a magnet equipped for either direct or alternating current, but it must be borne in mind that one may be without electricity and therefore without any magnet if the electric wires are cut or the power plant damaged by an attack from the air.

Fragments of shell, hand grenades, and air bombs are usually magnetic, but pieces from machine guns or rifle bullets are not (lead covered with an alloy coating).

Tetanus

(1) *Prevention.* Toxoid inoculation seems a good preventive. However, a wounded soldier should be given at once another 1 or 1½ c.c. of toxoid to reinforce his immunity. If not previously inoculated he should be given 3,000 international units of antitoxin and every week another 1,000 I.U. until his wound has healed completely. This preventive treatment should be given in cases of burns as well.

(2) *Treatment of declared tetanus.* (a) All remaining Cl. tetani should be removed by thorough surgical treatment.

(b) The neutralization of all the toxin not yet fixed on the nervous system should be undertaken by injecting antitoxin through all available channels: *1st day,* 12,500 by lumbar puncture, 12,500 intravenously, 12,500 in the vicinity of the wound (particularly near all the nerves); 12,500 in the thigh or abdominal muscles; *2d* day, 12,500 by lumbar puncture, 12,500 intravenously, 12,500 intramuscularly; *3d and 4th days,* 12,500 intravenously and 12,500 intramuscularly each day. Thereafter it does not seem useful to give any more antitoxic serum.[9]

(c) By the administration of narcotics, tetanic cramps and spasms and the hyperexcitability of reflexes must be prevented: avertin or a sufficient amount of barbital at night; during the day morphine or omnopon, or evipan, or short periods of chloroform anesthesia. Lumbar punctures are performed at this time.

(d) The patient's strength must be conserved by a sufficient diet or if necessary glucose proctoclysis.

Gas gangrene

Gas gangrene is practically nonexistent in wounds of the face and orbit. Preventive antitoxins are therefore not indicated as in the case of soiled wounds of the lower limb. Treatment would consist of incision, drainage, and the local and general use of sulfonamides. Roentgen treatment is also advisable. Antitoxin is less efficacious as a treatment than as a preventive, but should be employed.

Care of the wounded soldier

The wounded soldier is very different from the young healthy and vigorous man

inducted. His general resistance has usually been lowered just before and during the fight by physical exertion (long marches, lack of sleep), underfeeding in quantity and in quality (lack of fresh food), nervous and mental strain, exposure before being picked up by the stretcher bearers, and pain during transportation. The wounded soldier usually reaches the operating room with a low blood pressure and is sometimes already autointoxicated from his wound. If symptoms are more marked there is a condition of shock.

Shock

This is a condition of acute prostration with anoxia of the nervous centers and a very low blood pressure. There is probably an increased permeability of the capillaries, with loss of plasma in the tissues and stagnation of the blood in the capillaries, particularly in the splanchnic area. Symptoms point to a collapse of the circulation and of the sympathetic nervous system.

Patients in a condition of shock should not be operated upon at once but treated first. The only exception is in case of severe and persistent hemorrhage, but this is never the case in ophthalmology. The wounded soldier should be in a quiet and warm room. Heat should be applied either by means of hot water bottles (and these should be watched to avoid burns of the skin) or preferably by a heating apparatus under his blanket. He should be given hot drinks (sweet tea with some alcohol). Pain should be relieved (morphine but no barbiturates). Ephedrine is helpful, but no adrenalin should be given. But the most essential part of the treatment is a transfusion of fresh blood or of dried plasma (500 to 1,000 c.c. or more). In a couple of hours the patient has improved considerably and one can now operate without danger.

Aftercare

It seems hardly necessary to say that the greatest care should be taken not to infect the wound when it is dressed. Recent researches in Great Britain have shown that this is, however, more often the case than one imagines through contact, droplets, and dust.[10,11] The diet should be watched. Two points should be stressed: A high-protein diet is necessary in case of burns, and vitamin C is important for normal healing.[12]

One must bear in mind that vitamin C is not stocked in the body and that for several days before being wounded the soldier probably had a diet poor in vitamin C. He should, therefore, be given 75 to 100 mg. per day of ascorbic acid.

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THE GREAT USEFULNESS OF BICYLINDRIC COMBINATIONS IN THE EXPLORATION OF ASTIGMATISM

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Americans will not be surprised at the usefulness of bicylindric combinations in the exploration of astigmatism, since Jackson's use of cross cylinders, at present so widespread, is but a special instance of their value in testing refraction.

Bicylindric combinations have been applied by the Spanish school of refraction since 1909, when I discovered a variety of astigmatism which I called biastigmatism.[1] It is not a mere theoretic curiosity. It is actually a matter of considerable practical significance, the knowledge of which has benefited many thousands of patients. And it is interesting to note that while some opththalmologists, because of theoretic prejudices, refuse *a priori* to accept my opinions, those who have frequented my clinic and have seen my ideas put into practice are enthusiastic supporters of the ophthalmometric-subjective process that I recommend in view of the existence of biastigmatism. A practice of over 30 years enables me to state that this process is far more accurate than any others known up to the present time.

To consider an eye optically normal it is not enough that its visual acuity be V. = 1.00 and that every meridian of an astigmatic chart or clock dial appear the same, for many times, with V. = 1.25, V. = 1.50, and even more, there exist slight defects of refraction which, corrected, permit the eye to see 1.50, 1.75, or 2.00, and without accommodative asthenopia.

The existence of biastigmatism is unquestionable, for it is well known that corneal astigmatism, measured with the Javal-Schiötz ophthalmometer (or with other keratometers), often does not coincide with the total astigmatism either in dioptric value or as regards the inclination of its meridians. This is not surprising, since there are many refringent surfaces in the eye (the anterior and posterior surfaces of the cornea, the anterior and posterior surfaces of the crystalline lens, and the retinal surface) which may be deformed or may not be properly centered with regard to the optic axis. Thus it is clear that a partial astigmatism can occur at the level of each of these surfaces. Total astigmatism is the result of the various possible partial astigmatisms, and therefore, theoretically, there is mono-, bi-, tri-, and polyastigmatism. To Javal's statement[2] that astigmatism is the most frequent cause of defective eyesight, I would add that biastigmatism is the most frequently found variety of astigmatism.

Why do we single out biastigmatism? Because in practice there is but one astigmatism, the corneal anterior type, which can be measured accurately by means of an ophthalmometer, whereas the astigmatism that is caused by other surfaces can be measured only as a whole; for this reason it is not quite correct to call it crystalline astigmatism. It should be referred to as "residual" astigmatism (Tscherning's supplementary astigmatism), since this latter term does not imply the particular surface to which it relates.

It has been pointed out to me that the combination of two astigmatisms is equivalent to a third astigmatism as with the combination of two cylindric glasses, and that, consequently, it would be preferable to determine the single resulting astigmatism by the subjective method or by skiascopy. My answer to this is that although good results are obtained by this process

in a number of cases, there are other cases in which it is precisely a matter of skillful clinical tactics not to do it thus, it being better to correct both astigmatisms successively in order to determine the total astigmatism more accurately.

Let us see first of all how this exploration of biastigmatism is carried out.

The instruments consist of: (1) the Javal-Schiötz ophthalmometer, or some other keratometer. This is indispensable, since corneal astigmatism is the most important type of partial astigmatism. I agree with Professor Siegrist[3] that it is an instrument of the greatest value in the determination of astigmatism. And this view, which I held as early as 1906, as a result of my own researches,[4] gained strength after I discovered the existence of biastigmatism, for we are thus provided with an accurate and certain datum to be included in total astigmatism.

(2) An adequate scale of optotypes. It must not indicate letters, which are likely to be guessed, but simple optotypes such as Landolt's incomplete circle or Márquez's incomplete square.[5] It should provide for visual acuity ranging from V. = 1.00 to V. = 2.00, in order to explore those cases that are most interesting, in which there is but a small degree of astigmatism.

(3) An astigmatic chart or clock dial is also necessary. Those with 30-degree intervals between the radii are of no value. It is better to use charts with 15-degree intervals, or, better still, with 10-degree intervals, as in the Lancaster-Regan astigmatic chart.[6]

(4) A good trial frame providing for at least three glasses in front of each eye.

(5) A good trial case, with subdivisions of 0.25D., or, better still, of 0.12D. in the first few units.

The patient is placed at the necessary distance for examining refraction (5 or 6 meters, according to the country), and each eye is examined separately.

Once spheric refraction has been corrected, if it exists, the first cylinder is placed on the test frame, that is, the cylinder that corrects corneal astigmatism, according to the data revealed by skiascopy and the ophthalmometric formula. Regarding the latter I prefer to discard Javal's notation (for instance, L.E. ±90° 2D.) in favor of the Spanish notation, in which each meridian is preceded by its sign: L.E. −0° +90° 2D. This means that if we use a positive cylinder we must place +2 before 90°; if a negative one, −2 before 0°. In order to know whether we should use the one or the other we should refer to the datum revealed by skiascopy. Thus, if the shadows are inverted relatively to movement of the plane mirror, we should employ the negative cylinder; if they are direct and well outlined, the positive cylinder; and if they are direct but hardly discernible, or not at all, we may use either indiscriminately. In the latter case, the second cylinder to be used (or the spheric lens) will probably have a sign opposite to that of the first cylinder. Therefore, if we place the cylinder that corrects corneal astigmatism one of two things will happen: either the radii will appear unequal to the eye, or they will all appear equal.

If the radii appear unequal it is obvious that a second astigmatism is present. We then place cylindric glasses so that their axis is perpendicular to the radius which appears darkest, or perpendicular to the center radius if there is more than one, until every radius appears the same. Sight is thus improved and total astigmatism corrected.

If the radii appear equal to the patient we must not conclude at once that there is no second astigmatism, for if his hypermetropia is of small dioptric value, and he is young, then a second astigma-

tism may exist in a latent form as a result of unequal contractions of the ciliary muscle; that is, because of astigmatic accommodation (see below).

The device used to unmask this slight astigmatism consists in "myopizing," as we say in clinical "argot"; that is, in adding a +50D. sph. in order to transform hypermetropic into myopic astigmatism. The latter is undisguisable, and then the radii will appear unequal. They can be rendered equal by means of a concave cylinder placed with its axis perpendicular to the radius that appears to be darkest. By withdrawing the +0.50D. sph. or replacing it by a +0.25D. sph. sight improves and total astigmatism is corrected. If in spite of the device of "myopizing" radii continue to appear equal, although they may all appear hazy, it is because only corneal astigmatism is present. By means of the correction achieved by both cylinders, the eye may often attain a visual acuity of 1.50, 1.75, and even 2.00, if there are no lesions in the fundus of the eye and there is no *amblyopia ex anopsia.*

In enabling us to separate total astigmatism into its two component parts, corneal astigmatism and residual astigmatism, this exploratory process also shows the relationship between them. The results of combining both astigmatisms is similar to that of combining the two "cylinders of the eye," imitating Lindner's terminology[7]; that is, the two cylinders supposedly added to the emmetropic eye to produce biastigmatism.

The following cases may occur:

1. Corneal astigmatism and residual astigmatism may be absent, and therefore total astigmatism does not exist. This case is the least common of all.

2. Corneal astigmatism is present, but there is no residual astigmatism; in which case total astigmatism is equal to corneal astigmatism. This is also uncommon.

3. There is no corneal astigmatism but residual astigmatism is present; in which case total astigmatism is equal to residual astigmatism. The dioptric value of the latter is usually small, from 0.25 to 1.00D. when inverted (against the rule) or inverted-oblique, and in some cases when upright (with the rule), upright oblique, or oblique; in exceptional cases the dioptric value may be very large (Busto's cases. Soc. Oft. Hisp.-Amer., Valencia, 1916). It would be caused according to Schiötz and Tscherning[8] by the crystalline lens's not being properly centered.

4. Both corneal and residual astigmatism are present, their axes being parallel or perpendicular. It is a matter of adding or subtracting. There are thus two varieties of this type of biastigmatism: additive and subtractive.

A. ADDITIVE. TWO SUBTYPES:

(i) Parallel axes, with equal sign: A simple addition is carried out.

Example

$$-1.00\text{D. cyl. ax. } 0^\circ \eqsim -1.50\text{D. cyl. ax. } 0^\circ = -2.50\text{D. cyl. ax. } 0^\circ$$

(ii) Perpendicular axes, with opposite sign. The resulting astigmatism or cylinder is a spherocylindric lens, for which there are two solutions (three, if we include the bicylindric solution).

Example

$$-1.00\text{D. cyl. ax. } 0^\circ \eqsim +1.50\text{D. cyl. ax. } 90^\circ \quad \text{(a)}$$
$$= -2.50\text{D. cyl. ax. } 0^\circ \eqsim +1.50\text{D. sph.} \quad \text{(b)}$$
$$= +2.50\text{D. cyl. ax. } 90^\circ \eqsim -1.00\text{D. sph.} \quad \text{(c)}$$

It will be noticed that in each case the cylinder and sphere have opposite signs; that the resulting cylinder is equal to the sum of the two component cylinders and bears the sign of one of them; and that the sphere has the same dioptric value as the other cylinder, and the same sign.

A special case of this subtype is that in which both cylinders have the same dioptric value. The result is a cylinder of

double the dioptric value of the sphere and the same three solutions exist.

Example

$$\begin{aligned} &-1.00\text{D. cyl. ax. } 0^\circ \eqsim +1.00\text{D. cyl. ax. } 90^\circ && (a')\\ &= -2.00\text{D. cyl. ax. } 0^\circ \eqsim +1.00\text{D. sph.} && (b')\\ &= +2.00\text{D. cyl. ax. } 90^\circ \eqsim -1.00\text{D. sph.} && (c') \end{aligned}$$

B. SUBTRACTIVE, TWO SUBTYPES:

(i) Parallel axes, opposite signs: a simple subtraction.

Example

$$\begin{aligned} &-1.00\text{D. cyl. ax. } 0^\circ \eqsim +1.50\text{D. cyl. ax. } 0^\circ\\ &= +0.50\text{D. cyl. ax. } 0^\circ \end{aligned}$$

The resulting cylinder bears the sign of the larger of the two.

(ii) Perpendicular axes, same sign. The resulting cylinder is equal to the difference between the two, with the axis of the larger; the sphere will have the same value as the smaller cylinder.

Example

$$\begin{aligned} &+1.50\text{D. cyl. ax. } 90^\circ \eqsim +1.00\text{D. cyl. ax. } 0^\circ\\ &= +0.50\text{D. cyl. ax. } 90^\circ \eqsim +1.00\text{D. sph.} \end{aligned}$$

SPECIAL CASES: (1) Both astigmatisms or cylinders the same, with opposite sign: the resulting astigmatism or cylinder is zero.

Example

$$-1.00\text{D. cyl. ax. } 0^\circ \eqsim +1.00\text{D. cyl. ax. } 0^\circ = 0.\text{D.}$$

(2) If both astigmatisms or both cylinders are equal and bear the same sign and are perpendicular, they offset each other with regard to cylinders and the result is a sphere of the same sign and dioptric value.

Example

$$+1.00\text{D. cyl. ax. } 0^\circ \eqsim +1.00\text{D. cyl. ax. } 90^\circ = +1.00\text{D. sph.}$$

These two special cases are precisely those in which biastigmatism gives rise to zero total astigmatism, in both cases; besides, in the second, it gives rise to a spheric defect, hypermetropia or myopia, or to a plus or minus spheric lens.

5. Corneal and residual astigmatism, or both cylinders, forming oblique angles. These are the most frequent cases of biastigmatism. Both astigmatisms or both cylinders can have the same or a different dioptric value, with equal or opposite sign, and with varying inclination of the axes relative to each other, over 0° and under 90°. The defect or resulting lens is always a spherocylindric lens.

The dioptric value of the resulting astigmatism or cylinder is always smaller than the sum and greater than the difference of the first two cylinders.

The inclination of the axis is such that for astigmatisms or cylinders having the same sign it is found between the two axes of the two cylinders or astigmatisms that are combined. If they have the same dioptric value, it is found at the bisector of the angle formed between both axes. If unequal, nearer the axis of the larger. If both astigmatisms or cylinders have opposite signs, the axis of the resulting one is found by transposing one of them; thus two solutions are obtained according to which one is transposed. The astigmatism or cylinder will bear the opposite sign to that of the defect or spheric glass. It is well known that the transposed cylinder is equivalent to another cylinder of the same dioptric value, with opposite sign and perpendicular axis, plus a sphere of the same sign and dioptric value as the first cylinder.

Example

$$\begin{aligned} &-5.00\text{D. cyl. ax.}\\ &= +5.00\text{D. cyl. ax. } 90^\circ \eqsim -5.00\text{D. sph.} \end{aligned}$$

the latter spheric lens being taken into account to add it algebraically to the spheric lens, if such already existed, and to the spheric part resulting from the combination of the two cylinders converted into cylinders of the same sign.

Besides this process of transposing one of the cylinders, the problem can also be solved directly, without changing the signs, as I shall explain later.

The spheric part of the defect or resulting lens is solved by a simple formula set forth below.

There are three ways of solving every case of combination of two astigmatisms or two cylinders: by means of formulas, tables, or graphically. I have explained them in greater detail in another paper,[9] and shall give only a summary here.

In *formulas* we should distinguish between those relating to the refraction of the different meridians of each cylinder and those relating to bicylindric combinations.

In each cylindric lens, or in each astigmatism, refraction varies from the section that is parallel to the axis up to that which is perpendicular to it; but it does not vary gradually with the inclination, in an upward arithmetic progression, as most textbooks on medical optics state. Refraction increases or decreases according to the formula $r = R \sin^2 a$, in which r is the value of refraction at the level of the meridian in question, R is the refraction at the section perpendicular to the axis of the cylinder, and a is the angle formed between the meridian of r and the axis of the cylinder. Once the corresponding values for a lens of 1.00D. are obtained by means of this formula for each degree (in practice, it is sufficient to obtain them for 5-degree intervals), we may find the values of lenses of greater or smaller dioptric value, multiplying at the level of each meridian the partial values by 1, 2, 3, and so forth, or by 0.12, 0.25, 0.50, and so on. Thus the combinations can be carried out as will be seen below.

The following are the formulas for bicylindric combinations. C_1 is the first cylinder or corneal astigmatism, C_2 the second cylinder or residual astigmatism, and C_3 the third cylinder or total astigmatism; a, is the angle formed between C_1 and C_2; i_1, the angle formed between C_3 and C_1; i_2, the angle formed between C_3 and C_2; and E, the spheric lens.

(1) Dioptric value of the resulting cylinder C_3:

$$C_3 = \sqrt{C_1^2 + C_2^2 + 2\,C_1C_2 \cos 2a} \qquad [1]$$

(2) Dioptric value of the sphere E:

$$E = \frac{C_1 + C_2 - C_3}{2} \qquad [2]$$

(3) Inclination of the axis of C_3 over C_1 or over C_2 (either of the following two formulas may be used):

$$\sin 2i_1 = \frac{C_2}{C_3} \sin 2a \qquad [3]$$

$$\sin 2i_2 = \frac{C_1}{C_3} \sin 2a \qquad [4]$$

The values sought can be derived with the aid of trigonometric and logarithmic tables.

The *tables* can be constructed in two ways. In the first place, according to the formula for one cylinder, $r = R \sin^2 a$, employing the values of each of two cylinders in columns, or by means of two concentric circles, so that the 0° point of the smaller cylinder coincides with the number of degrees of the larger cylinder corresponding to the angle formed between the two axes. The corresponding values for each meridian are added, and it will be found that one of these shows the minimum value and the other the maximum value. The minimum value is that of the spheric part; the corresponding inclination is that of the axis of the resulting cylinder relative to that which is at 0°; the difference between the maximum and minimum values is the dioptric value of C_3. The first tables,[10] which I presented at the London Medical Congress in 1913, were thus constructed under my direction by my disciple and friend, Dr. Busto. But as this process, although easier than the use of formulas, was nevertheless somewhat burdensome, Dr. Busto proceeded to construct new transformation tables[11] derived directly

from formulas [1], [2], [3], and [4], for bicylindric combinations.

Hence the second way of constructing them, the calculations having been made beforehand and being easily read off.*

The *graphic methods* are sufficiently accurate and practical for those who do not possess the tables, or are not able or do not wish to use them.

Diagrams are required, showing concentric circumferences with equal distances between them, each interval being equivalent to one diopter. For greater accuracy, the diagram can be drawn on a wall or a large blackboard, with three lightly drawn circumferences between every two heavily drawn circumferences, in order to represent fourths of a diopter; or seven light lines if eighths of a diopter are to be shown. These are Kraemer's and Nitsche and Guenter's processes.

1. Kraemer's process[12] is applied for cylinders of opposite sign. The description of this process follows.

Let us assume (fig. 1) the following combination:

Example

+5.00D. cyl. act. 60° ⌯ —2.00D. cyl. act. 30°

"First, a line is drawn from the center, corresponding to the stronger cylinder (A), according to the dioptric value of its active section [Kraemer prefers, and rightly in my opinion, to refer to the *active section* of the cylinder instead of referring to the axis or inactive section]; the same is done for the weaker cylinder (B); the latter is made to turn until the angle formed by the two is duplicated (up to B′); the side (A B′) closing the triangle corresponds in length to the dioptric value of the cylindric part of the spherocylindric combination; that is, to the new cylinder. Draw the bisector of the angle opposite the weaker cylinder, after the latter has been moved, and the line parallel to it from the center; when prolonged until it reaches the degree mark of the outside circle, it indicates the active direction of the new cylinder, on which the length of A B′ is now measured indicating fairly accurately the dioptric value of the new cylinder; this cylinder

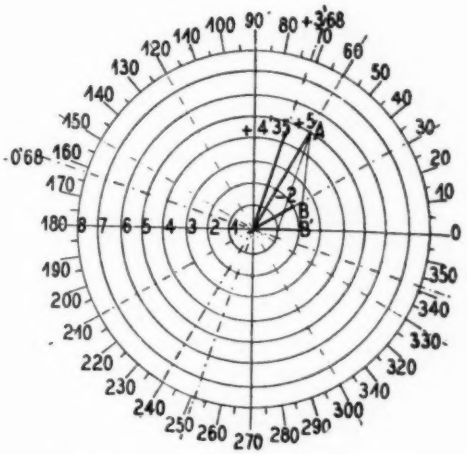

Fig. 1. Kraemer's process applied for cylinders of opposite sign.

always has the same sign as the larger component. The spheric part is obtained with formula [2] mentioned above, and the sign of this spheric lens is always opposite to that of the resulting cylinder."

In this case the cylindric part is equivalent to +4.35D. cyl. act. at 72°. The spheric part is expressed as follows, according to formula [4],

$$E = \frac{+5 + (-2) - 4.35}{2} = \frac{-1.35}{2} = -0.67$$

The spherocylindric lens corresponding to the bicylindric combination +5.00D. cyl. act. 60° ⌯ —2.00D. cyl. act. 30° will then be:

+4.35D. cyl. act. 72° ⌯ —0.67D. sph.

This value is equivalent to two others:

—4.35D. cyl. act. 162° ⌯ +3.68D. sph.
= +3.68D. cyl. act. 72° ⌯ —0.67D. cyl. act. 162°

* The third edition of these tables will be published as an appendix to my forthcoming book, "Astigmatism, biastigmatism, cylindrical glasses, and bicylindrical combinations."

That is, every combination of two cylinders with oblique axes, opposite signs, and different dioptric values can be expressed by two spherocylindric combinations, or by another bicylindric one with perpendicular active sections. In all three, the two resulting lenses will have opposite signs and unequal dioptric values.

In the bicylindric combination both active sections are found as follows: The

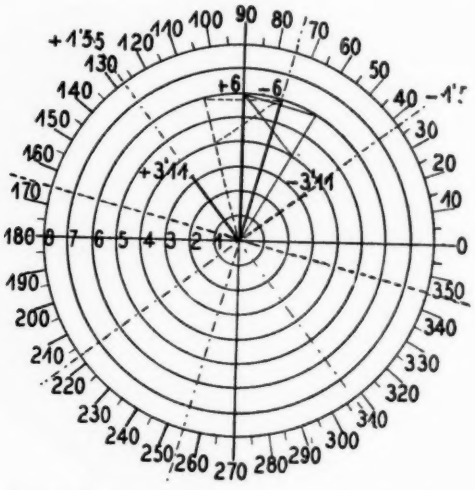

Fig. 2. Both cylinders with opposite signs have the same dioptric value.

section with maximum dioptric value is nearer the maximum in the active section in the angle formed between the latter and the axis of the minimum-value cylinder; the section with minimum dioptric value is nearer the axis of the maximum-value cylinder in the angle formed between the latter and the minimum in the active section. As regards the dioptric values of the two cylinders the stronger is the one that corresponds to the sign of the larger in the original combination.

If both cylinders with opposite signs have the same dioptric value, two graphic constructions are possible, according to whether we consider one as fixed and the other as movable, or vice versa. In figure 2, which refers to combination +6.00D. cyl. act. 90° ⌯ −6.00D. cyl. act. 75°, the two solutions are shown by continuous or broken lines, respectively. Both results are equivalent; the combination mentioned is equivalent to each of the following three:

−3.11D. cyl. act. 37½° ⌯ +1.55D. sph.
+3.11D. cyl. act. 127½° ⌯ −1.55D. sph.
+1.55D. cyl. act. 127½° ⌯ −1.55D. cyl. act. 37½°

The result of every combination of two cylinders with oblique axes, opposite signs, and the same dioptric value can also be expressed by two spherocylindric combinations or by another bicylindric one with active perpendicular sections. In all three cases, both the resulting lenses will have opposite signs. In the two spherocylindric combinations, both cylindric lenses will have twice the dioptric value of the spheric lenses. In the bicylindric combination, the dioptric values of the two cylinders are equal to one another and also have half the dioptric value of the cylinder in the former spherocylindric combinations.

It can be seen also that the position of the two active sections, plus and minus, in this mixed astigmatism is, for the maximum one, at the bisector of the angle formed between the active section of the larger cylinder and the axis of the smaller cylinder, and for the minimum one at the bisector of the angle formed between the active section of the smaller cylinder and the axis of the larger cylinder.

2. For cylinders with the same sign, Nitsche and Guenter's (of Ratenow) process is used,[13] consisting in a construction similar to that of a parallelogram of forces (fig. 3). Using the same example as in figure 1, but transposing one of the cylinders (say, the smaller one) in order that they may both have the same sign, we obtain combination +5.00D. cyl. act. 60° ⌯ +2.00D. cyl. act. 120° ⌯ −2.00D. sph. It is important to remember that the construction must

be done duplicating the number of degrees of the angle of each of the component cylinders and halving that of the resulting cylinder. Thus, cyl. +5.00D. at 60° becomes +5.00D. at 120°, and +2.00D. at 120° becomes +2.00D. at 240°; the parallelogram's diagonal is obtained at 144°, which means that the active section of the cylinder is obtained by halving this figure to 72°, its dioptric value being +4.35D. The spheric lens will be, according to formula [2],

$$E = \frac{+5 +2 -4.35}{2} = \frac{+2.65}{2} = +1.32.$$

But as this result must be added to −2.00D. sph. (since the cylinder −2.00D. has been transposed), the final sphere will be +1.32 −2.00 = −0.68. Therefore, the spherocylindric lens will be +4.35D. cyl. act. 72° ⌯ −0.68D. sph.; that is, practically the same result as that yielded by Kraemer's process.

Particular significance should be attached to cases in which total astigmatism is very small, precisely because its two component astigmatisms almost offset each other. Sometimes they bear the same, or almost the same, dioptric value, have opposite signs, and their axes are parallel or almost so (angles from 5° to 10°); or they may have the same sign, but perpendicular, or almost perpendicular, axes (80° to 85°). They are special cases of the subtractive or additive astigmatisms pointed out above (4, A and B), or of those with oblique axes (5).

A special case occurs when total astigmatism is zero (4, B) precisely because both component astigmatisms offset each other exactly; but if they do not quite offset each other total astigmatism may have a very small dioptric value, even though corneal astigmatism and residual astigmatism be fairly important, say of 1.00D., 1.25D., or 1.50D. each. Two conclusions may be drawn from this. First, that when total astigmatism is very small it can easily be offset by small partial contractions of the ciliary muscle, always in the same direction, although it may lead sooner or later to accommodative asthenopia, especially if the subject is temporarily weak due to a systemic disease. Second, that when corneal astigmatism is corrected with the first cylinder the ciliary muscle cannot offset the residual astigmatism, which is stronger than the total astigmatism, since it would

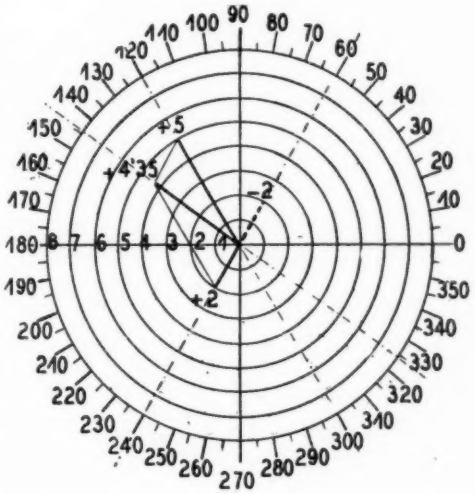

Fig. 3. Nitsche and Guenter's process applied for cylinders with the same sign.

have to exert more powerful contractions and in other than the usual direction; consequently the residual astigmatism is rendered clearly visible and can be corrected with the second cylinder. These are the cases in which visual acuity, which may be normal or almost so before correction, diminishes when the first cylinder is applied and improves again with the second cylinder even to the point of being better than it was originally, though often the same; asthenopia, however, disappears.

It should be noted also that in these cases in which the explored eye attains a normal or supernormal visual acuity and

sees every radius equally black, the ordinary subjective procedure is usually ineffective, even if recourse is had to "myopizing." In such cases, only the ophthalmometric-subjective procedure permits an accurate correction of these small astigmatisms that are latent. This leads me to add a few words on the subject of astigmatic accommodation.

I fail to understand how anyone could doubt the existence of astigmatic accommodation, for there is considerable evidence of it. First, young subjects who are not astigmatic are capable of offsetting weak concave cylinders ranging from 0.50 to 0.75D. and often more. They see every radius of the astigmatic chart the same, and this can be achieved only by unequal contractions of the ciliary muscle. Second, latent hypermetropic astigmatisms in such young people become manifest under the effects of cycloplegics. Third, these same disguised hypermetropic astigmatisms cease to be so when we make them artificially myopic through the device of "myopizing," a device which also shows up a total hypermetropic astigmatism ranging from 0.50 to 0.75D., but which is not so useful in very small astigmatisms, since these tend to correct themselves through partial contractions which equalize the maximum and minimum meridian, even though it leads to asthenopia (the opposite never happens, for there is no negative accommodation). These are the aforementioned cases which only the ophthalmometric-subjective procedure can uncover. Finally, there are cases of spasmodic myopic astigmatism due to self-hypercorrection of hypermetropic astigmatism; they are similar to those of young hypermetropic subjects in whom spheric self-correction leads to spasmodic myopia, which can only be made to disappear with the aid of mydriatics.

I shall now refer to an error concerning the alleged accommodation for the different planes of Sturm's conoid. When astigmatic accommodation is incapable of equalizing simultaneously the refraction of all the meridians of the eye, due to the fact that astigmatism may be larger than 1.00D. and that the subject may be older, it may happen that accommodation occurs successively for each of the two focal lines (never for the focal interval). It is more frequent for the horizontal focal line (when the two main meridians of total astigmatism are vertical and horizontal), the vertical line appearing more intense as a result of the well-known "astigmatic paradox." This is the reason why in ordinary letter scales, in which vertical lines predominate, these lines appear more intense, and the subject's sight improves although his astigmatism has been exaggerated, not corrected. Thus it can be understood why the eye sometimes "accepts" a weak cylindric glass the axis of which is perpendicular to the direction it should actually have.[14] At times there are also rapid accommodations alternating from one focal line to the other; and this, according to Crisp,[15] explains the asthenopia and the irritative symptoms of some astigmatic eyes. Although I accept this explanation in some cases, it seems to me that asthenopia is for the most part caused by a sustained contraction of the ciliary muscle in cases of small astigmatism in which the refraction of the different meridians is achieved even though the effort leads to asthenopia. This does not happen in cases of considerable astigmatism, since the corrective contractions would be insufficient.

After correction has been carried out with the two cylinders, what do we do with them? The bicylindric combination can be transformed into a spherocylindric one, and this can be done readily with the aid of the formulas, the tables, or the graphic method. On the other hand, it is

not quite correct to say that I always prescribe the bicylindric combination, since in most cases I prefer the spherocylindric combination, which is easier to make and is more economical. However, sometimes the subject's sight improves much more with a bicylindric combination when the resulting spherocylindric glass contains a fraction that differs appreciably from the fractions opticians usually make; in such a case I prescribe a bicylindric combination. This occurred, incidentally, in my first case of biastigmatism, when the left-eye ophthalmometric formula was −90° +0° 0.75D., and the correction was −0.75D. cyl. ax. 90° ⌯ −1.00D. cyl. ax. 105°, being equivalent to the spherocylindric combination −1.69D. cyl. ax. 100° ⌯ −0.03D. sph. This explained why correction was never achieved with only one cylinder from the trial case. Consequently, the opticians, Messrs. Garay-Escolar, of Madrid, carried out the prescription by joining the two cylinders by their plane surfaces with Canada balsam, turning them to form the corresponding angle. In other cases in which the spherocylindric combination differs but slightly from the usual fractions, I prescribe this combination. For instance, +0.75D. cyl. ax. 0° ⌯ +1.50D. cyl. ax. 40° is equivalent to +0.29D. sph. ⌯ −0.78D. cyl. ax. 30°, and can be substituted, without incurring any significant inaccuracy, by +0.25D. sph. ⌯ +0.75D. cyl. ax. 30°.

Under certain circumstances, the subject may see better with the spherocylindric combination that results from neglecting fractions—apparently the less exact one—than with the original, exact one. This is due to the fact that the two astigmatisms that serve as a starting point for observation may not have been strictly accurate, so that the combination that is believed to be merely approximate turns out to be more accurate.

If we compare the ophthalmometric-subjective procedure with Jackson's cross-cylinder process, we find that the latter is really but a special case of the former, that in which both cylinders have the same dioptric value, opposite signs, and perpendicular axes. As I indicated earlier (4, A, ii, special case), this bicylindric combination is equivalent to each of the two spherocylindric combinations in which the cylinder has double the value of the sphere and the opposite sign. The cross-cylinders employed are −0.12D. with +0.12D., −0.25D. with +0.25D., −0.50D. with +0.50D., and −1.00D. with +1.00D. Consequently, this process amounts to using one cylinder only; but as the latter, in a case as −0.12D. cyl. ax. 0° ⌯ +0.12D. cyl. ax. 90°, is equivalent to one of the following combinations:

−0.25D. cyl. ax. 0° ⌯ +0.12D. sph.

or,

+0.25D. cyl. ax. 90° ⌯ −0.12D. sph.

it is evident, therefore, that in the most favorable case the sensitiveness of this procedure is not greater than 0.25D. cyl. Since cross-cylinders have to offset a mixed astigmatism, their maximum practical effect will occur when, in a myopic eye with astigmatism or in a hypermetropic eye with astigmatism, the corresponding spheric refraction, plus or minus, is slightly overcorrected, and the cylindric refraction undercorrected. If instead of limiting ourselves to the use of cross-cylinders we have recourse to all kinds of bicylindric combinations of equal or different dioptric value, equal or opposite sign, and any inclination between 0° and 90°, as in our ophthalmometric-subjective procedure, we will obtain greater sensitiveness since we then have dioptric values in the cylinder from 0D. to the sum of both cylinders.

Therefore, notwithstanding the opinion of several colleagues, among them Lindner, who maintains that cross-cylinders[16]

"constitute the most adequate aid for the subjective test" (a view all the more surprising in this distinguished professor from Vienna, since he has always shown himself definitely in favor of every kind of bicylindric combinations for the objective test, that is, for skiascopy with cylinders), I believe that the sensitiveness of the bicylindric procedure generally—that is, of the ophthalmometric-subjective method—is much greater than that of cross-cylinders or any other subjective process for exploring astigmatism.

Therefore, I invite all the eminent refractionists who have read this paper to put this procedure into practice, without prejudice; they will be sure to find it useful for their patients.

Report of a few recent cases

Case 1. J. F., a youth, aged 15 years, consulted me on October 16, 1941. He had accommodative asthenopia. Ophthalmometric formula and visual acuity: L.E. −175° +85° 1.50D. V. = 0.9; R.E. −5° +95° 1.00D. V. = 1.25 (difficult).

Correction: The skiascopic shadows appeared to move with the plane mirror, and, therefore, I utilized convex cylindric glasses for the first cylinder.

L.E. +1.50D. cyl. ax. 85° ⌓ −1.00D. cyl. ax. 95° ..... V. = 1.25, radii equad
= +1.50D. cyl. ax. 85° ⌓ +1.00D. cyl. ax. 5° ⌓ −1.00D. sph.
= +0.66D. cyl. ax. 70° ⌓ +(0.92 − 1.00)D. sph. ..... (Tables)
= +0.66D. cyl. ax. 70° ⌓ −0.08D. sph.
= *+0.62D. cyl. ax. 70* ⌓ ..... V. = 1.25, radii equal

R.E. +1.00D. cyl. ax. 95° ⌓ −0.75D. cyl. ax. 85° ..... V. = 1.75, difficult, radii equal
= +1.00D. cyl. ax. 95° ⌓ +0.75D. cyl. ax. 175°
⌓ −0.75D. sph.
= +0.39D. cyl. ax. 115° ⌓ +(0.68 − 0.75)D. sph. ..... (Tables)
= +0.39D. cyl. ax. 115° ⌓ −0.07D. sph.
= *+0.37D. cyl. ax. 115°* ..... V. = 1.75, difficult, radii equal

With the binocular correction V. = 1.75 easily.

I prescribed both the italicized formulas for farsight and for nearsight, with resultant disappearance of the asthenopia.

Case 2. Miss M. J., aged 16 years, consulted me on February 10, 1942. Her eyesight was more acute than the normal average. She complained of accommodative asthenopia and headache. Ophthalmometric formula and visual acuity: L.E. −5° +95° 1.00D. V. = 1.50; R.E. −170° +80° 1.50D. V. = 1.50, difficult. Correction:

L.E. +1.00D. cyl. ax. 95° ⌓ −1.00D. cyl. ax. 85° ..... V. = 2., radii equal
= −1.00D. cyl. ax. 5° ⌓ −1.00D. cyl. ax. 85° ⌓ +1D. sph.
= −0.35D. cyl. ax. 45° ⌓ (−0.83 +1.00)D. sph. ..... (Tables)
= −0.35D. cyl. ax. 45° ⌓ +0.17D. sph.
= *−0.37D. cyl. ax. 45° ⌓ +0.25D. sph.* ..... V. = 2., radii equal

R.E. +1.50D. cyl. ax. 80° ⌓ −1.00D. cyl. ax. 70° ..... V. = 2., radii equal
= +1.50D. cyl. ax. 80° ⌓ +1.00D. cyl. ax. 160°
⌓ −1.00D. sph.
= +0.66D. cyl. ax. 95° ⌓ (+0.92 −1.00)D. sph. ..... (Tables)
= +0.66D. cyl. ax. 95° ⌓ −0.08D. sph.
= *+0.62D. cyl. ax. 95°* ..... V. = 2., radii equal

Orthophoria. I prescribed both the italicized formulas for far- and nearsight with resultant disappearance of the as-

thenopia and headache.

Case 3. J. L., aged 42 years, consulted me on February 12, 1942. Eyelids and conjunctiva were reddened. Eyesight was normal for distance, presbyopia for near. Ophthalmometric formula: L.E. −0° +90° 0.75D. V. = 1.25, difficult; R.E. −170° +80° 0.50D. V. = 1.50, difficult.

Correction:

L.E. +0.75D. cyl. ax. 90° ⊂⊃ −0.87D. cyl. ax. 70°.....V. = 1.75, radii equal
= −0.75D. cyl. ax. 0° ⊂⊃ −0.87D. cyl. ax. 70°
⊂⊃ +0.75D. sph.
= −0.57D. cyl. ax. 40° ⊂⊃ (−0.53 +0.75)D. sph.....(Tables)
= −0.57D. cyl. ax. 40° ⊂⊃ +0.22D. sph.
= *−0.50D. cyl. ax. 40° ⊂⊃ +0.25D. sph.*.....V. = 1.75, radii equal

R.E. +0.50D. cyl. ax. 80° ⊂⊃ −0.50D. cyl. ax. 90°.....V. = 1.75
= −0.50D. cyl. ax. 170° ⊂⊃ −0.50D. cyl. ax. 90°
⊂⊃ +0.50D. sph.
= −0.17D. cyl. ax. 130° ⊂⊃ (−0.41 +0.50)D. sph.....(Tables)
= −0.17D. cyl. ax. 130° ⊂⊃ +0.09D. sph.
= *−0.25D. cyl. ax. 130°*.....V. = 1.75, radii equal

I prescribed both the italicized formulas for farsight. For nearsight there is a presbyopia and I added +1.00D. sph. to the former correction.

Case 4. J. P., aged 29 years, consulted me on March 31, 1942, because he had an exophoria and wore spheric glasses only (−5.00D. L.E., and −5.50D. R.E.) with which he obtained a visual acuity of 0.8, difficult, for each eye. Ophthalmometric formula: L.E. −45° +135° 0.50D.; R.E. −170° +80° 0.25D.

Correction:

L.E. −5.00D. sph. ⊂⊃ −0.50D. cyl. ax. 45°.....V. = 1.75, difficult, radii equal
⊂⊃ +0.75D. cyl. ax. 45°
= *−5.00D. sph. ⊂⊃ +0.25D. cyl. ax. 45°*.....V. = 1.75, difficult, radii equal
R.E. −5.00D. sph. ⊂⊃ −0.25D. cyl. ax. 170°.....V. = 1.75, difficult, radii equal
⊂⊃ +0.50D. cyl. ax. 0°
= −5.25D. sph. ⊂⊃ +0.25D. cyl. ax. 80°
⊂⊃ +0.50D. cyl. ax. 0°
= −5.25D. sph. ⊂⊃ +0.25D. cyl. ax. 10°.....(Tables)
⊂⊃ +0.25D. sph.
= *−5.00D. sph. ⊂⊃ +0.25D. cyl. ax. 10°*.....V. = 1.75, radii equal

Binocular acuity V. = 2.

I prescribed for distance vision the italicized formulas. For near vision, exophoria existing, corrected by 4° prism, for each eye, I prescribed prisms 2°, bases in, the same formerly cylindric glasses and −3.50D. sph.

It is remarkable how the visual acuity increased with a −0.25D. cylinder and how, in spite of the myopia, vision became better than the average normal.

Summary

There is a skillful process of investigating, chiefly the small degrees of astigmatism, based on the unquestionable existence of biastigmatism, and consisting in the employment of every kind of bicylindric combination. The first cylinder corrects the corneal astigmatism according to ophthalmometric measures (by Javal-Schiötz or another keratometer). The second cylinder is searched for (after the corneal astigmatism has been corrected, and, if necessary, the spheric refraction) by the clock dial, as in the usual process of subjective exploration of astigmatism until the intensity of all diameters is equalized. Once having found the two cylinders, the resultant single cylinder is obtainable (with or without a spheric fraction) by means of

formulas, graphs (both processes having been described in the text of this paper), or tables. This bicylindric process has a sensitiveness much greater than that of Jackson's cross-cylinder test (which is only a special variety of the former) or any other subjective process for exploring astigmatism.

Paseo de la Reforma 157.

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THE EFFECT OF UNDERCORRECTION AND BASE-IN PRISM UPON THE MYOPIC REFRACTIVE STATE*

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Various statements have appeared to the effect that the wearing of glasses with a marked undercorrection of myopia tends to decrease the myopia if, in addition to the undercorrection, base-in prism is incorporated in the lenses. The reason for such a procedure, as usually stated, is based upon the reflex relationships that exist between accommodation and convergence in binocular vision.

It is well known that for every stimulus to accommodation in the act of seeing, there is an associated stimulus to convergence of the visual axes. This accommodation-convergence reflex has, in the presence of marked hypermetropia, been considered to be a contributing factor in the formation of convergent strabismus. Less commonly known is the so-called convergence-accommodation reflex in which, when convergence under fusional stimuli occurs, there is usually present an associated accommodation. This reflex is particularly prominent when fusional convergence is near the critical limit and diplopia imminent.

Theoretically, therefore, if base-in prism were incorporated in the corrective prescription it would, under the demand of fusional stimuli, reduce the convergence necessary for binocular vision and also, on the basis of the above-mentioned convergence-accommodation reflex, tend to inhibit accommodation. If, in addition to this the corrective lenses are of such power as to result in an undercorrection of the existing myopia there may be present a further tendency to inhibit accommodation in the interest of clear vision. According to the proponents of this theory a reduction in myopia results from such constant dual inhibitory action on accommodation.

This theory has become more plausible since the works of Henderson,[1] Cogan,[2] and Olmsted, Morgan, and Watrous[3, 4, 5] were published.

These investigators have shown conclusively that the ciliary body, which regulates focus of the eye, is reciprocally innervated by both branches of the autonomic nervous system. Excitation by the parasympathetic with reciprocal inhibition by the sympathetic causes accommodation, or a relative myopia with respect to the basic refractive state. On the other hand, excitation by way of the sympathetic with reciprocal inhibition by the parasympathetic results in a relative hypermetropia with respect to the basic refractive state. For the purposes of this discussion the basic refractive state may be defined as that refractive state in which only normal autonomic tone is present. Morgan, Olmsted, and Watrous[5] have shown that these two types of refractive change are quite dissimilar. The change resulting from parasympathetic excitation is of the order of 10 diopters; that resulting from sympathetic excitation is of the order of 1 diopter. This difference is largely due to the difference in mechanical advantage of the ciliary muscle fibers innervated by the two branches of the autonomic nervous system, as Henderson[1] has clearly shown. Thus it is apparent that what has been thought to be a simple relaxation of accommodation in the change

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of ocular focus from near to distance fixation is really a reciprocally innervated dynamic change in the refractive state. This concept lends plausibility to the reduction of myopia by the wearing of glasses combining undercorrection with base-in prism. The work of Olmsted *et al.*, however, gives a limit to the degree of reduction in myopia physiologically possible. This limit is apparently one diopter on the average, unless pseudomyopia is present.

It seemed to the writers desirable to determine whether marked undercorrection and base-in prism did in fact decrease myopia. In the evidence so far presented no attempt to segregate the various types of myopia has been made. It is the impression of the writers that previous experimentation in this field has been inadequately controlled, and that many of the cases showing reduction in myopia may have been pseudomyopic. This seems a distinct possibility since no cycloplegic examination was performed to eliminate such cases in any of the reports that have come to our attention.

For this investigation 13 subjects, ranging in age from 18 to 24 years, were selected from resident students at the University of California. All of these students exhibited myopia of less than two diopters. Some of them had been myopic for a number of years; others had myopia of more recent orgin. Each student was subjected to a careful preliminary examination. The refractive state of each eye was determined by retinoscopy and by subjective testing with trial lenses and the Snellen test chart. The distance phoria, abduction, and adduction were determined. Then, after prior tonometric measurements of ocular tension had been made as a precautionary measure, cycloplegia was induced by instilling 1-percent homatropine hydrobromide in the conjunctival sac of each eye. Two drops were instilled in each eye at intervals of five minutes until three instillations had been made. Forty minutes later, after the so-called residual accommodation had been ascertained in order to assure a state of complete cycloplegia had been induced, a retinoscopic and subjective examination of the monocular refractive state was made. Several postcycloplegic refractive examinations, in no case less than two, were made to eliminate the effect of chance factors upon the determination of the refractive state.

Of the 13 subjects, 11 showed a negligible change in the refractive state under cycloplegia (less than one-quarter diopter); the other two showed changes from myopia of low degree to a slight hypermetropia in one case, and to a lower degree of myopia in the other. The condition in these latter two subjects suggested a pseudomyopia and hence will be so designated; the other 11 will be classed as exhibiting true myopia.

Each student was then given glasses incorporating a spherical undercorrection of the myopia of the order of one diopter and from 4^{Δ} to 6^{Δ} of total base-in prism. The degree of prism given was dependent upon the individual amplitude of abduction; those having the lower abduction received the 4^{Δ} base-in prisms. These glasses were worn constantly for three months for all visual acts.

In an attempt to enhance the effects of the refractive correction during this period, the students came three times a week for orthoptic training. For the orthoptic training the subject observed a Snellen chart at a distance of 15 feet through his glasses. This chart could be alternately illuminated and darkened. The patient attempted to clear up a line on the Snellen chart that was one or two lines below the one that was clearly seen. During this attempt the illumination on the chart was turned on and off, so that a succession of

distinct efforts to clear up blurred imagery was made by the subject. These orthoptic periods lasted for about 15 minuts, including three or four short rest periods. Occasionally an added base-in prism was used in an attempt further to relax any existing convergence-accommodation. Once each week a retinoscopic and subjective determination of the refractive state was made to evaluate the progress, if any, in each case.

The results of these procedures were definite. In the case of the 11 subjects who exhibited true myopia no change in the refractive state was obtained, whereas in the case of the two classed as pseudomyopic the myopic state was eventually reduced to the cycloplegic refractive state. In these two latter cases, the precycloplegic and cycloplegic examinations were as follows:

Case 1

		Right Eye			Left Eye		
		Sphere	Cyl.	Axis	Sphere	Cyl.	Axis
Precycloplegic examination	Retinoscopy	−0.75D.	−0.25D.	180°	−0.75D.	−0.25D.	180°
	Subjective	−0.50D.	−0.25D.	180°	−0.75D.	−0.25D.	180°
Cycloplegic examination	Retinoscopy	−0.25D.	—	—	−0.25D.	−0.25D.	180°
	Subjective	plano	—	—	−0.25D.	−0.25D.	180°

Case 2

		Right Eye			Left Eye		
		Sphere	Cyl.	Axis	Sphere	Axis	Cyl.
Precycloplegic examination	Retinoscopy	−0.25D.	−0.50D.	180°	−0.25D.	−0.25D.	120°
	Subjective	−0.25D.	−0.50D.	180°	−0.25D.	−0.50D.	120°
Cycloplegic examination	Retinoscopy	+0.25D.	−0.50D.	180°	+0.25D.	−0.25D.	90°
	Subjective	+0.25D.	−0.50D.	180°	+0.25D.	−0.25D.	90°

It is interesting to note that several of the students who had true myopia showed an increased visual acuity, as measured on the Snellen chart, with no change in either the subjective or objective refractive state. This is interpeted as an increased ability to recognize blurred outlines of similar objects as a result of practice; and this may be the basis for the claims of others that true myopia has been reduced by such procedures. Significantly, if these individuals be tested with test charts with the multiple-circle or broken-circle characters like the Verhoeff ring or the Ferree-Rand double broken circle such increase in visual acuity is not observed. Six of the subjects reported that during the time they wore the lenses they were able to study longer without fatigue. This seems an expected result, as neither convergence nor accommodation demands were so great at the near point with the glasses as without.

From these measurements, the conclusion seems justified that the wearing of glasses constituting an undercorrection of myopia and incorporating base-in prism of from 4^{Δ} to 6^{Δ} has little, if any, tendency to reduce myopia unless such myopia is pseudomyopia. It seems reasonable to assume that if any real tendency toward reduction of true myopia existed, such should have been observed in some of the subjects. It should be mentioned, however, that these experiments neither invalidate nor confirm claims that the wearing of an undercorrection combined with base-in prism tends to inhibit the increase of simple myopia.

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EVALUATION OF GLAUCOMA OPERATIONS*

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Ideal postoperative results for the relief of glaucoma are so rarely seen in the laboratory that histologic studies of the material at the New York Eye and Ear Infirmary were made to determine the causes of failure. A survey was made of approximately 100 eyeballs and an attempt was made to select representative sections showing the common operations performed for the relief of increased intraocular pressure. The operations included paracentesis, posterior sclerotomy, iridectomy, iris inclusion, and trephining.

The histologic findings in the globes studied were so similar that it was often difficult to tell the exact operation or operations performed for the relief of glaucoma. The outstanding characteristic of all of the specimens was the failure to reduce the extent of the anterior peripheral synechiae by surgery. Practically all of the sections showed that the operative incisions were so far anterior to the normal angle of the iris that basal iridectomies could not have been effected. Many of the wounds contained remnants of the iris and ciliary processes, and prolapse of the crystalline lens had occurred at times. The uveal remains were often replaced by dense keloidlike connective tissue. Almost all of the wounds were sealed by fibrous tissue, in which evidence of inflammatory reaction remained. Colonies of lymphocytes and plasma cells with congested blood vessels and localized edema contributed to the general picture along the line of incision.

A brief description of the microscopic findings in specimens representing the common operations for glaucoma follows.

Paracentesis

Paracenteses were performed in so many of the cases that special attention was given to two of the eyes.

Specimen 1. The first eye, which was enucleated after paracentesis, was hyperopic in type and was sectioned to one side of the optic nerve. The crystalline lens was cataractous, the pupil dilated, and broad anterior peripheral synechiae were present. A linear incision, 2 mm. anterior to the limbus and parallel to the plane of the iris, extended through the cornea. The anterior chamber was of normal depth but contained fibrin and albuminous fluid.

Most of the corneal epithelium was lost by bleb formation. The patches of epithelium remaining showed edematous and hemorrhagic changes. In the periphery, Bowman's membrane was replaced by inflammatory changes and beginning de-

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generative pannus. The stroma of the cornea was characterized by interstitial inflammation and fibrotic changes. The line of incision was clearly outlined by lymphocytic infiltration, small congested blood vessels, and degenerated uveal pigment. Descemet's membrane was intact and barely dimpled at the wound. Flakes of pigment covered the incision in the endothelium and were scattered over its surface. The anterior chamber was filled with an albuminous fluid containing fibrin. There were broad peripheral adhesions of the iris to the posterior surface of the cornea which closed the drainage channels. The iris was atrophic, showing complete destruction of the chromatophores and migration of degenerated pigment cells. The ciliary body portrayed

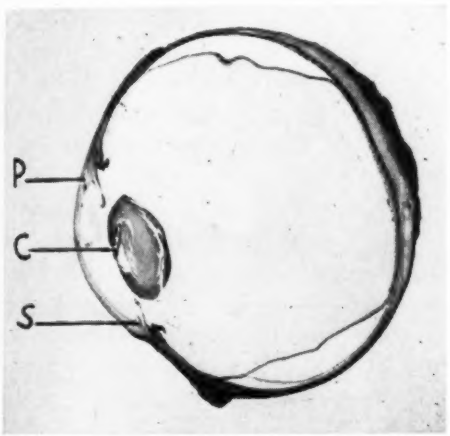

Fig. 1 (Payne). Section showing "P" line of paracentesis incision; "C" cataractous lens; "S" broad anterior peripheral synechiae.

generalized atrophic changes with destruction of the epithelium, hyalinization of the ciliary processes, congestion of the blood vessels, fibrous replacement of the muscle, and generalized lymphocytic infiltration. The choroid demonstrated essentially the same changes as those seen in the iris and ciliary body. The pigment epithelium showed signs of disintegration. The retina, although comparatively well preserved, presented congested blood vessels, destruction of ganglion cells, and generalized edema with hemorrhage on its inner surface. The crystalline lens showed cortical vacuoles and nuclear

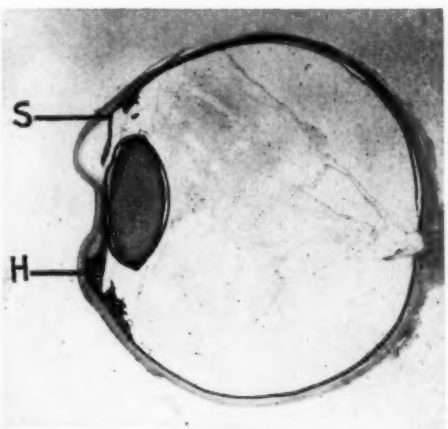

Fig. 2 (Payne). Section shows enlargement of the crystalline lens and pathologic cupping of the optic nerve; "S" broad anterior peripheral synechiae; "H" hyphema.

sclerosis, changes which are often seen when diabetes mellitus is present.

Specimen 2. The second specimen was a myopic eye, its cornea collapsed by fixation. It was characterized by enlargement of the crystalline lens, hemorrhage into the anterior chamber, broad anterior synechiae, and pathologic cupping of the optic nerve. The sections failed to include the operative wound.

Examination of the cornea showed edema of the epithelium, with some denuded areas exposing Bowman's membrane. Degenerative pannus was progressing from the limbal region. The stroma was thinner than normal, but showed little inflammatory change, and the endothelium was covered with fibrin and hemorrhage containing pigment. The hyphema filled the lower part of the anterior chamber and extended into the

obliterated pectinate spaces. The anterior adhesions of the iris completely blocked any approach to the canal of Schlemm, and a membrane was beginning to form on the anterior surface of the iris and extend over the surface of the crystalline lens behind a thin mantle of red blood cells and pigment. The iris, adherent to the lens capsule below, was slightly thinner than normal. In the iris and ciliary body, such atrophic changes were present as destruction of chromatophores, migration of particles from the pigment layers, and diffuse infiltration with lymphocytes. The ciliary processes showed hyalin changes. The choroid was compressed by fixatives. The retina was generally atrophic, with the loss of many ganglion cells; the optic nerve was deeply cupped, with a glial membrane lining the cavity. The stalk of the nerve showed marked atrophic changes. The crystalline lens was swollen and sclerosed. The vitreous body was detached and contained many cellular masses and some red blood cells.

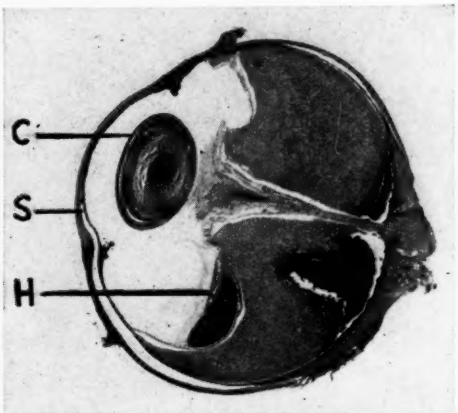

Fig. 3 (Payne). Specimen shows complete detachment of the retina with subretinal hemorrhage; "H" pre-retinal hemorrhage; "S" complete anterior synechiae; swollen crystalline lens.

The specimens represent cases of glaucoma, complicated by diabetes mellitus in which the eye was lost after a paracentesis operation. A study of the cases treated by paracentesis shows that filtration was not restored; hemorrhage and inflammatory changes may necessitate enucleation.

Posterior sclerotomy

Only one specimen representing a posterior sclerotomy is needed to show most of the complications that may occur as a result of the operation. The globe was of the negroid hyperopic type, with the entire retina detached and the iris completely adherent to the cornea. A pre-retinal and subretinal hemorrhage were present; the crystalline lens was swollen.

The cornea was characterized by edema and loss of epithelium. Pannus and interstitial inflammation extended from the periphery. Descemet's membrane was preserved, but the endothelium was hidden by a complete adhesion of the iris to the cornea. The iris contained degenerated blood and pigment granules as well as diffuse lymphocytes. The ciliary body was undergoing atrophy with degeneration of the epithelium, hyalinization of the processes, and fibrous replacement of the muscle fibers. The blood vessels were congested, and diffuse lymphocytic infiltration extended back into the choroid, which was compressed by pressure and fixation. The retina was completely detached and formed a cone filled with glial and connective tissue to serve as a cushion for the posterior surface of the crystalline lens. Hemorrhage, serum, and an albuminous fluid separated the retina from the choroid. The retina pulled the optic papilla forward to form the apex of the cone. The optic nerve was in the stage of advanced atrophy, with old hemorrhage filling a patch of glial spaces formerly occupied by nerve fibers. An island of lymphocytes extended from the pia mater into the nerve bundles on one side. The crystalline lens was swollen and showed cortical and nuclear changes. It maintained its position by resting in a

bed of organized connective and glial tissue and forming the base of the retinal cone.

It is obvious that there was little to be gained from this operation and enucleation should have been performed at the beginning.

Iridectomy

Iridectomy was performed in so many of the cases studied that three were selected to demonstrate the causes of failure.

Specimen 1. The specimen was slightly larger than normal in size and shape and was characterized by a large bulla of the cornea, iridectomy, enlargement of the crystalline lens, and pathologic cupping of the optic nerve. Microscopic examination in the region of the operation showed edema and diffuse round-cell infiltration. The cornea was somewhat thinner than normal, and the epithelium formed a large bulla over the apex. Bowman's membrane was intact except in the region of the limbus, where pannus was beginning to form. The corneal stroma showed changes induced by tension. Descemet's membrane extended over the anterior surface of the iris, and the endothelium was covered with a thin layer of round cells, fibrin, and pigment particles. The sclera was thinner than normal and showed little of importance. The iris was characterized by atrophy, broad anterior peripheral synechiae, and pathologic ectro-

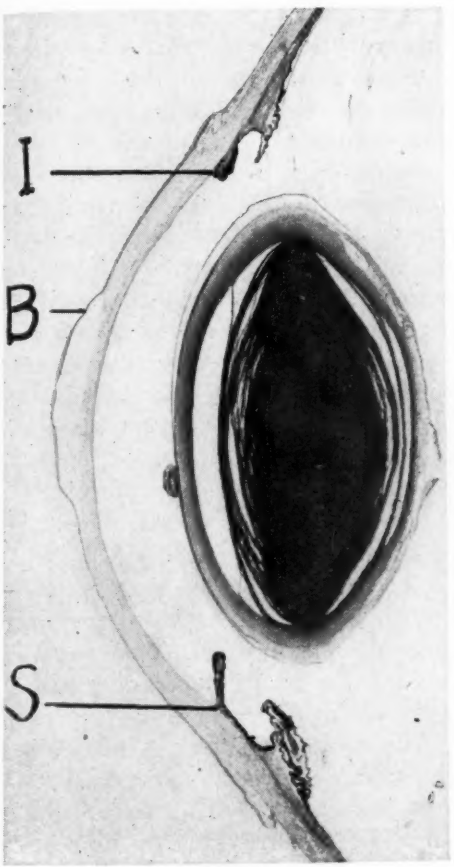

Fig. 4 (Payne). Photomicrograph showing "I" iridectomy stump; "B" bulla; "S" broad anterior synechia.

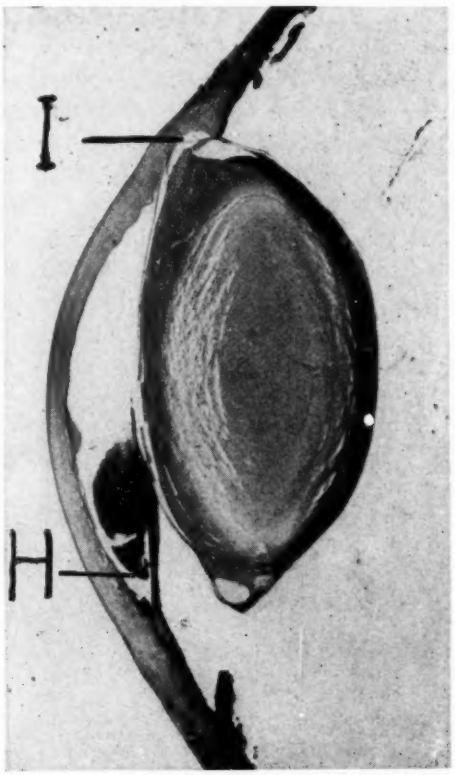

Fig. 5 (Payne). Photomicrograph with "I" herniation of the crystalline lens into the operative wound; "H" hyphema.

pion of the uvea. The iris stump extended far anteriorly to the filtration angle, which had been closed by adhesions. The membrane extending over the anterior surface of the iris, and contributing to the ectropion, had firmly sealed any possible connection with the lower drainage spaces. The ciliary body showed atrophic changes, and the choroid was flattened to a mere line by pressure and

Fig. 6 (Payne). Section shows raw edge of the iris "I" severed by operation.

fixation. The optic nerve was atrophic and pathologically excavated. A glial mantle separated the vitreous body from the optic cup. The retina showed destruction of the ganglion cells and edema, especially in the macular area. The crystalline lens had undergone posterior cortical changes with nuclear sclerosis. A fragment of iris remained on the anterior surface of the lens and was forming a capsular cataract.

Careful study of this specimen indicated that iridectomy failed to create a new drainage channel and the synechiae were undisturbed. The presence of a bulla contributed to the loss of the eye.

Specimen 2. This specimen was characterized by a generalized thinning of the fibrous tunic, dislocation and herniation of the crystalline lens, hemorrhage into the anterior chamber, and pathologic excavation of the optic nerve.

Examination of the cornea showed considerable thinning in the vicinity of the operative wound, with the crystalline lens bulging into its lips. Pannus separated the epithelium from Bowman's membrane. The stroma was uneven in thickness and showed depositions of blood pigment. Descemet's membrane joined the lens capsule at the operative wound and covered the iris on the opposite side. The endothelium was obscured by hemorrhage, fibrin, and cellular deposits. The iris was atrophic and adherent to both cornea and lens. The ciliary body and choroid showed atrophic changes with some diffuse round-cell infiltration. The retinal changes were characterized by hemorrhage and ganglion-cell degenerations. The optic nerve was excavated and atrophic. Hemorrhage into the cortex with cataractous changes were seen in the ectopic lens.

The eye was lost through herniation of the lens and intraocular hemorrhage.

Specimen 3. The third globe was hyperopic and characterized by marked enlargement of the crystalline lens, shallow anterior chamber, operative coloboma, and pathologic cupping of the optic nerve.

The cornea was thinner in the center than at the periphery, the epithelium absent over the apex, edematous and undermined by hemorrhage at the limbus. Degenerative pannus was beginning, and the external sulcus was filled with loose edematous connective tissue that con-

tained congested blood vessels and lymphocytic infiltration. Diffuse peripheral interstitial inflammation was evident. Descemet's membrane was preserved, but the endothelium was covered by a thin layer of red blood cells, fibrin, and degenerated pigment. The filtration angle was occluded by broad peripheral adhesions, and hemorrhage filled the pseudoangle on the lower side. The iridectomy left a raw, exposed stump of the iris, failed to include the base, and gave no relief to the synechia. The iris was diffusely infiltrated with lymphocytes and plasma cells. Pigment remains on the anterior surface of the lens indicated the presence of posterior adhesions of the iris. The ciliary body and choroid were undergoing similar degenerative changes. The retina showed marked cystic degeneration and evidence of thrombosis of the central vein. A deep excavation of the optic nerve with disorganized columns of nuclei indicated advanced atrophy. The central vessels were replaced by fibrous tissue. The crystalline lens was generally swollen, its nucleus sclerosed.

This specimen was removed because the pressure was not relieved by the operation, and the iridectomy failed to include the base of the iris.

Iris-inclusion operation

Iris-inclusion operations were represented by two eyes that were lost after successful filtration channels were established. The crystalline lenses were the cause of both enucleations because of their pressure on the lips of the operative wounds.

Specimen 1. Examination of the first specimen showed the crystalline lens to be greatly swollen and impinging on the operative wound. The anterior chamber was practically replaced with lens and iris. A hemorrhage separated the macular area of the retina from the pigment epithelium.

The filtration wound showed an edematous bleb, filled with loose connective tissue, permeated by congested blood vessels, and infiltrated with lymphocytes. Diffuse hemorrhage had occurred, and a cyst lined with the pigment layer of the iris lay close to the surface. Ciliary processes and a part of the iris limited the inner margins of the wound, and the crystalline lens was molded against the iris from the margin of the wound to the pupillary border, replacing the anterior chamber in this area. The corneal epithelium was well preserved, pannus was

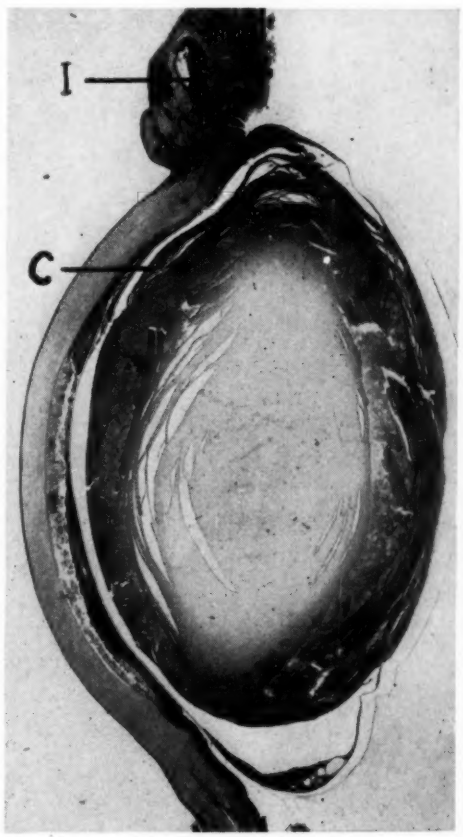

Fig. 7 (Payne). Specimen showing "I" iris inclusion; "C" cortical cataract.

absent, but there was some interstitial inflammation. Descemet's membrane remained intact, but the endothelium disappeared in the adhesions and was covered by hemorrhage and pigment in the central region. The iris was atrophic and prolapsed into the wound. Broad anterior and posterior synechiae were present. The hemorrhagic condition of the iris

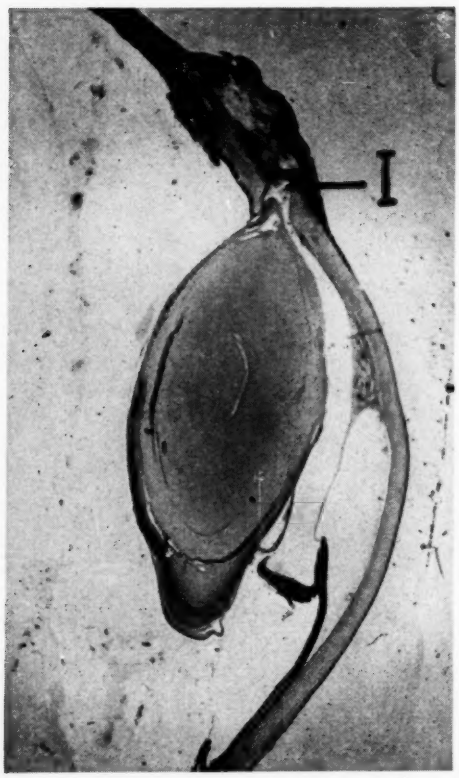

Fig. 8 (Payne). Photomicrograph showing "I" iris inclusion with herniation of the crystalline lens.

extended posteriorly into the ciliary body, and the choroid was congested. A pyramidal hemorrhage separated the macular area of the retina from the pigment epithelium and the choroid. The optic nerve was not included in the sections. The crystalline lens was swollen and undergoing cortical cataractous changes. The equator and anterior surface of the lens formed a part of the innermost lip of the wound.

The eye was lost in spite of a new filtration channel created by surgery. The prolapse of the iris and ciliary processes with the ectopic lens was incompatible with preservation of the globe.

Specimen 2. This specimen, representing an iris-inclusion operation, showed generalized enlargement of the globe with considerable thinning of the fibrous tunic. The equator of an ectopic lens filled the inner surface of the wound. An extensive anterior synechia included most of the remaining iris. Pathologic cupping of the optic nerve was present. The microscopic findings in the region of the operative wound showed edematous connective tissue, permeated by congested vessels and infiltrated with lymphocytes. A small epithelial-lined cyst appeared near the surface. The inner border of the wound contained a thin atrophic layer of the iris which had been pressed forward by lens cortex. A part of the lens capsule was included in a densely organized area on the posterior surface of the cornea. The corneal changes resembled those of the preceding specimen. The iris was atrophic and adherent to the cornea but separated from the lens by the operation. Other changes in the globe were typical of advanced glaucoma.

An ectopic cataractous lens filling the mouth of the wound played an important part in the loss of the eye. The accidental rupture of the lens capsule may have contributed to cyst formation in the wound and the anterior chamber.

Trephining operation

Trephining operations for the relief of glaucoma presented a general picture illustrated by the specimen to be described.

The eye was hyperopic in type and characterized by a shallow anterior cham-

ber, swollen cataractous lens, and deep pathologic excavation of the optic nerve. The cornea was irregular in thickness. The epithelium was well preserved but slightly undermined by new blood vessels and connective tissue at the limbus. The stroma was moderately infiltrated in the periphery. Descemet's membrane was curled on itself near the operative wound, and the endothelium was covered with hemorrhage and fibrin. The operative wound was closed by dense connective tissue containing fragments of pigment, lymphocytes, and new blood vessels. The filtering cicatrix contained fresh hemorrhage. The iris was atrophic and closely adherent to the cornea on the side not operated on. A peripheral iridectomy had been performed, as was evidenced by a part of the iris lying in apposition to the crystalline lens. The ciliary body and the choroid showed atrophic changes with congestion of the blood vessels. The retina was undergoing degenerative changes with diffuse hemorrhage in its innermost layers. The optic nerve was excavated and atrophic. The crystalline lens presented cortical cataractous changes with nuclear sclerosis. The lens capsule was in close relation to the filtration wound.

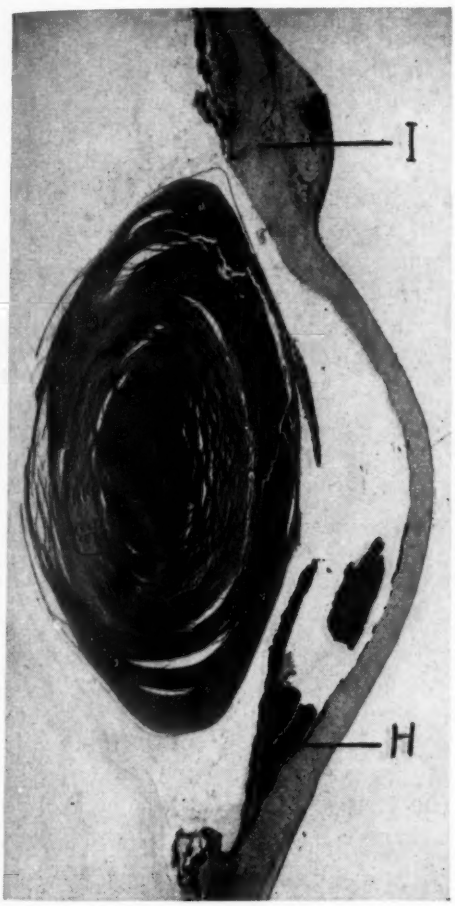

Fig. 9 (Payne). Section showing "I" scleral trephine wound; "H" hyphema.

Tight closure of the wound with dense fibrous tissue, a swollen cataractous lens, and an intraocular hemorrhage undoubtedly caused the loss of the eye.

Conclusions

A satisfactory evaluation of operations for glaucoma would appear to be hopeless in the face of the cases just described. From the findings it would seem that any type of surgical procedure must be doomed to failure. It should be remembered, however, that these specimens represent failures, and despite the fact that there is no satisfactory operation for glaucoma there is some hope in the choice of surgical procedure. In reviewing the material for this paper, which was collected over a period of 10 years, it was noted that most enucleations followed paracentesis, posterior sclerotomy, and iridectomy. The number of specimens submitted after iris-inclusion operations, corneosclerectomy, and trephining amounted to less than 15 percent of the total. From the viewpoint of the pathologist it seems that some form of corneosclerectomy is the operation of choice.

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CHANGES IN MINERAL COMPOSITION OF RAT LENSES WITH GALACTOSE CATARACT*

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Human cataractous lenses, especially of the senile type, have been analyzed by several investigators[1, 2, 3, 4, 5] for their mineral constituents, such as K, Na, Ca, Cl, PO_4, and SO_4, and found to differ considerably from normal lenses in this respect. Cataractous lenses contain much less potassium and phosphate, but more sodium, calcium, chlorine, and sulfate as compared with normal lenses. There is, however, considerable diminution in total solids and an increase in the water content in cataractous as compared with normal lenses. The loss in solids consists chiefly of soluble protein, sugar, and phospholipids. It has been concluded that the human senile cataract is the cumulative result of various endogenous and exogenous injurious agencies acting over a longer or shorter period of time, leading finally to the disintegration or autolysis of the lens tissue.

In order to throw additional light on the nature of human cataract, a great deal of work has been done with a view to inducing experimental cataracts in animals by various treatments. At the present time, considerable attention is being given to galactose cataract, induced in rats by supplementing their normal diets with relatively large amounts of galactose (25 percent). This type of cataract was produced first by Mitchell and Dodge[6] of the Massachusetts State College, at Amherst, in 1934 to 1935, and the experiments are still being continued at that institution. An arrangement was therefore made between Dr. Mitchell and us to have the rats with cataracts sent to us for chemical analysis of their lenses.

In our laboratory, immediately after the rats had been killed by ether, the lenses were extracted by the intracapsular method. They were collected in a closed dish over ice, then weighed on a sensitive chemical balance, dried to constant weight, and again weighed. The difference in the two weights represented the amount of water extracted.

In all, 342 cataractous lenses were obtained. They were classified into two groups according to stage of cataract; that is, incomplete and complete cataracts. There were 186 lenses in the former and 156 lenses in the latter group. A third group of lenses was secured from normal rats of the same strain and approximately the same age. These lenses, 119 in number, were perfectly clear and also normal in every other respect.

The analyses consisted in determinations of the water content, ash, potassium, sodium, calcium, chlorine, phosphate (PO_4), sulfate (SO_4), and carbonate (CO_3) by calculation. The three groups of lenses were incinerated separately in a platinum dish for 12 hours at a temperature of 465°C. After weighing the ash, it was dissolved in nitric acid, and the solution transferred to a 50-c.c. volumetric flask. An aliquot amount of the solution was used in each determination. The methods for determinations of the various constituents were as follows: Salit's[7, 8] microcolorimetric methods for potassium and sodium; Clark-Collip's[9] modification of Kramer-Tisdall's[10] method for calcium; Volhard-Harvey's[11] method for chlorine; Whitehorn's[12]

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TABLE 1

INORGANIC CONSTITUENTS OF NORMAL AND CATARACTOUS RAT LENSES

Condition of lenses	Normal	Partial cataract	Complete cataract
Number of lenses	119	186	156
Average wet weight	49.5 mg.	30.5 mg.	32.0 mg.
Average dry weight	20.0 mg.	8.0 mg.	6.2 mg.
Solids	40.29%	26.19%	19.41%
Water content	59.71%	73.81%	80.59%
Ash, on the basis of:			
Wet weight	0.617%	0.862%	0.923%
Dry weight	1.535%	3.291%	4.771%
Water content	1.034%	1.168%	1.144%
Potassium, on the basis of:			
Wet weight	0.222%	0.199%	0.165%
Dry weight	0.552%	0.761%	0.815%
Water content	0.371%	0.269%	0.195%
Ash	35.91%	23.11%	17.07%
Sodium, on the basis of:			
Wet weight	0.078%	0.168%	0.213%
Dry weight	0.193%	0.641%	1.052%
Water content	0.130%	0.227%	0.252%
Ash	12.60%	19.49%	21.74%
Calcium, on the basis of:			
Wet weight	0.005%	0.012%	0.019%
Dry weight	0.012%	0.044%	0.096%
Water content	0.008%	0.016%	0.023%
Ash	0.786%	1.350%	2.010%
Chlorine, on the basis of:			
Wet weight	0.029%	None	None
Dry weight	0.071%		
Water content	0.048%		
Ash	4.612%		
Phosphate (PO_4), on the basis of:			
Wet weight	0.240%	0.215%	0.171%
Dry weight	0.593%	0.817%	0.885%
Water content	0.399%	0.289%	0.212%
Ash	38.57%	24.78%	18.54%
Sulfate (SO_4), on the basis of:			
Wet weight	0.024%	0.074%	0.120%
Dry weight	0.058%	0.185%	0.620%
Water content	0.039%	0.124%	0.147%
Ash	3.80%	8.96%	13.00%
Carbonate (CO_3), on the basis of:			
Wet weight	0.023%	0.192%	0.269%
Dry weight	0.057%	0.735%	1.330%
Water content	0.039%	0.260%	0.318%
Ash	3.72%	22.31%	27.64%

colorimetric method for phosphorus; a modification of Rosenheim-Drummond's[13] benzidine-sulfate method for sulfur. The carbonate was determined by difference; that is, by subtracting the sum-totals of all the ions, determined by direct analysis, from the weights of the ash in the three groups of lenses. The results, which are similar to those for human cataractous lenses, are represented in tables 1, 2, and 3.

The average wet weight of the normal rat lens is 49.5 mg. The average wet weights of the cataractous lenses are 30.5

TABLE 2

THE SUM-TOTALS OF CATIONS ($K^+ + Na^+ + Ca^{++}$) IN THE THREE GROUPS OF LENSES

Condition of Lenses	Normal percent	Partial Cataract percent	Complete Cataract percent
On the basis of:			
Wet weight	0.305	0.379	0.397
Dry weight	0.757	1.446	1.963
Water content	0.509	0.502	0.470
Ash	49.30	43.95	40.82

and 32.0 mg. for partial and complete cataracts, respectively. The average dry weights of the three groups of lenses are 20.0, 8.0, and 6.2 mg., representing 40.40, 26.22, and 19.375 percent of solids of their total wet weights, respectively. There is thus a considerable loss of solids and an increase in water content in cataractous as compared with normal lenses. There is, however, an increase in the ash from 0.617 percent in normal lenses to 0.862 and 0.823 percent in the cataractous lenses as calculated on the basis of wet weight. Therefore the gross loss in solids in cataractous lenses is represented entirely by organic matter, chiefly by proteins. The ash is distributed much more uniformly between the three groups of lenses on the basis of water content, the values being 1.034 percent for normal lenses, and 1.168 and 1.144 percent for cataractous lenses. This means that the total concentration of inorganic constituents is determined chiefly by the water content of the lens tissue.

TABLE 3

THE SUM-TOTALS OF ANIONS ($Cl^- + PO_4^{---} + SO_4^{--} + CO_3^{--}$) IN THE THREE GROUPS OF LENSES

Condition of Lenses	Normal percent	Partial Cataract percent	Complete Cataract percent
On the basis of:			
Wet weight	0.316	0.481	0.560
Dry weight	0.779	1.735	1.835
Water content	0.525	0.673	0.677
Ash	50.70	56.05	59.18

Potassium decreases from 0.222 percent in normal lenses to 0.199 and 0.165 percent in cataractous lenses on the basis of wet weight. On the basis of water, the respective values are 0.371, 0.269, and 0.195 percent. On the basis of ash they are 35.91, 23.11, and 17.07 percent. Similarly the phosphate (PO_4) decreases from 0.240 percent in normal lenses to 0.215 and 0.171 percent in cataractous lenses on the basis of wet weight, or from 0.399 to 0.289 and 0.212 percent on the basis of water, and from 38.57 to 24.78 and 18.54 percent on the basis of ash, respectively. There is some chlorine in normal lenses, amounting to 0.029 percent on the basis of wet weight, 0.048 percent on the basis of water, and 4.612 percent on the basis of ash. The cataractous lenses, however, gave no response to the test for chlorine. In this respect rat lenses, probably on account of their low ages, differ from human cataractous lenses, in which there was even an increase in chlorine as compared with practically normal lenses. On the other hand, in agreement with results for human cataractous lenses, the sodium content increases from 0.078 in normal lenses to 0.168 and 0.213 percent in cataractous lenses on the basis of wet weight, from 0.130 to 0.227 and 0.252 percent on the basis of water, and from 12.60 to 19.49 and 21.74 percent on the basis of the ash content. Similarly, the calcium increases from 0.005 percent in normal lenses to 0.012 and 0.019 percent in cataractous lenses on the basis of wet weight, from 0.008 to 0.016 and 0.023 percent on the basis of water, and from 0.786 to 1.35 and 2.01 percent on the basis of ash, respectively. Likewise the sulfate (SO_4) increases from 0.024 percent in normal lenses to 0.074 and 0.120 percent in cataractous lenses on the basis of wet weight, from 0.039 to 0.124 and 0.140 percent on the basis of water, and from 3.80 to 8.96 and 13.00 percent on the basis of ash, respectively. The carbonate (CO_3) increases from 0.023 percent in normal lenses to 0.192 and 0.269 percent in cataractous lenses on the basis of wet weight, or from 0.039 to 0.260 and 1.330 percent on the basis of water, and from 3.72 to 22.31 and 27.64 percent on the

basis of ash, respectively.

Computed on the basis of dry weight, all inorganic constituents increase in cataractous lenses as compared with normal lenses. This is another evidence of the extraordinary losses of solids; that is, proteins, in cataractous lenses.

Since certain ionic constituents increase and others decrease as the lenses become more and more cataractous, the sum-totals of all the ions (K^+, Na^+, Ca^{++}, Cl^-, PO_4^{---}, SO_4^{--}, CO_3^{--}), as represented by the ash contents, and computed on the basis of wet weight and especially water content of the lens tissue, show far lesser changes than those noted between their individual constituents at any given stage of the cataract development (table 1). When the sum-totals of the ionic concentrations are computed separately for the two types of ions, cations (K^+, Na^+, Ca^{++}) and anions (Cl^-, PO_4^{---}, SO_4^{--}, CO_3^{--}), the former show greater uniformity in distributions than the latter between the three groups of lenses, both on the basis of wet weight and water content (tables 2 and 3). Therefore the negative ions must be more intimately concerned with the degenerative changes in the lens tissue than the positive ions. On the whole, there is a greater increase in the negative than in the positive ions as the lenses become more and more cataractous. This is especially shown when the results are computed on the basis of the total ash left after incineration. Thus the sum-total of the negative ions constitutes 50.70 percent of the total ash of normal lenses, but amounts to 56.05 and 59.18 percent of the ash of cataractous lenses (table 3). The sum-total of the positive ions, on the other hand, constitutes 49.30 percent of the ash of normal lenses, but only 43.95 and 40.82 percent of the ash of cataractous lenses.

Summary

In all, 461 rat lenses, extracted by the intracapsular method, were analyzed for water content, ash, and all the cations and anions that the animal tissue is supposed to contain in measurable quantities. Of these lenses, 119 were normal, 186 had incomplete cataracts, and 156 had complete cataracts. All the cataracts were induced experimentally by feeding rats relatively large amounts of galactose.

The water content of the lenses increases from 59.60 percent in normal lenses to 73.78 and 80.625 percent in cataractous lenses. The total ash rises from 0.617 percent in normal lenses to 0.862 and 0.923 percent on the basis of wet weight, and from 1.034 to 1.168 and 1.144 percent on the basis of water content, respectively. The changes in the individual ionic constituents, which are very pronounced, are as follows: Potassium, phosphate (PO_4), and chlorine decrease, but sodium, calcium, sulfate (SO_4), and carbonate (CO_3) increase in cataractous lenses. Their sum-totals, however, as represented by the ash contents and calculated on the basis of wet weight and water content of the respective three groups of lenses, differ much less from each other. The sum-totals of the cations (K^+, Na^+, Ca^{++}) show greater uniformity of distribution among the three groups of lenses than those of anions (Cl^-, PO_4^{---}, SO_4^{--}, CO_3^{--}) both with respect to wet weight and water content. The degenerative processes of the lens tissue are therefore more intimately connected with changes in the anions than with those in the cations. On the whole, there is a greater increase in the negative than in the positive ions as the lens becomes more and more cataractous.

In general, the changes are similar to those that occur in human senile cataracts.

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CHEMOTHERAPY IN ACUTE GONOCOCCAL CONJUNCTIVITIS*

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Since the publication of first American report[1] of the use of sulfanilamide in the treatment of acute gonorrheal conjunctivitis, a number of authors have confirmed the value of the drug in this condition. In 1939 Barbour and Towsley[2] reported their results from a group of 15 patients treated before the advent of sulfanilamide and compared them with those from 15 patients treated with the drug. There was a striking reduction in the period of hospitalization, as well as a reduction of serious visual defects from 26.6 percent to 0. Since that time several authors[3,4,5] have reported on the treatment of larger groups of patients with the sulfonamide drugs. Two reports[4,5] indicate that sulfapyridine is superior to sulfanilamide for gonococcal conjunctivitis, and one report[5] places sulfathiazole intermediately between the two. In another recent report,[6] however, the results from sulfanilamide therapy are not striking, and principal reliance is placed on local applications and irrigations in treating this condition.

The present report is presented to reemphasize the value of the sulfonamide drugs in the treatment of acute gonococcal conjunctivitis, to report on the use of sulfadiazene,† and to compare the relative efficiency of sulfanilamide, sulfapyridine, sulfathiazole, and sulfadiazene in the treatment of this condition.

MATERIAL

The present study is based on the case records of 102 patients suffering from acute gonococcal conjunctivitis who were admitted to the pediatric or contagious-disease wards of the Gallinger Municipal Hospital from July 1, 1938, to March 31, 1942. In order to get a better comparison of all the sulfonamide drugs, the patients previously reported[4] are again included. There has been no selection of patients. Every individual on the service who conformed to the diagnostic criteria outlined below is included in the series.

The four groups of patients who received the different drugs were not treated concurrently. That they are relatively similar in race and age, however, is shown in tables 1 and 2.

DIAGNOSIS

The diagnosis of these patients was established by (1) the clinical finding of a reddened, edematous eye with a severe purulent conjunctival discharge, and (2) demonstration of gram-negative intracellular diplococci of typical morphology in the stained films of the ocular discharge. Cultures of this discharge were made in a number of instances and when positive for *Neisseria gonorrhoeae* were considered positive evidence of the nature of the infection. However, the discharges from some eyes were not cultured and not all cultures were positive. In the absence of a positive culture typical clinical and microscopic findings were accepted as evidence of gonococcal ophthalmia.

TREATMENT

All these patients were admitted to the pediatric or contagious-disease wards of the Hospital and were isolated in separate rooms. Their general treatment was uniform throughout. The patients were kept

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† The sulfadiazene was supplied by the Lederle Laboratories, Inc., Pearl River, New York.

TABLE 1

COMPARISON BY RACE OF PATIENTS RECEIVING VARIOUS SULFONAMIDE DRUGS FOR ACUTE GONOCOCCAL CONJUNCTIVITIS

Type of Treatment	Race of Patients				
	Total	White		Colored	
		no.	percent	no.	percent
Total	102	18	17.6	84	82.4
Sulfanilamide	28	4	14.3	24	85.7
Sulfanilamide and sulfapyridine	4	1	25.0	3	75.0
Sulfapyridine	46	8	17.4	38	82.6
Sulfathiazole	8	4	50.0	4	50.0
Sulfadiazene	16	1	6.2	15	93.8

in bed and were given general supportive care. The eyes were irrigated with a warm boric-acid solution or an 0.8-percent solution of sulfanilamide frequently enough to keep the conjunctival sacs free of discharge. A 10-percent solution of argyrol was instilled into the conjunctival sac several times a day, usually half an hour before the eye was irrigated. In patients with unilateral involvement, the noninfected eye was protected from infection.

The chemotherapeutic agents were given immediately after smears had been taken and the diagnosis had been established. The dosage was the same for all drugs used. This consisted of the administration of an immediate dose of from 0.3 to 0.6 grains per pound of body weight, followed by a daily maintenance dose of approximately 1.0 grain per pound. The maintenance dose was divided into six equal portions, which were given at four-hour intervals. If the clinical response was not favorable, the dosage of the drugs was increased to 3 or even 5 grains per pound of body weight per day. In a few cases the sodium salt of sulfapyridine was given intravenously to promote a rapid increment of the drug in the blood stream. A 5-percent solution was used, and doses of 0.4 to 0.5 grains per pound of body weight were given every 6 to 12 hours as indicated.

Any patient who did not recover within two weeks after the drug was given was deemed to have failed to respond to the drug. In all cases except in those showing no response, the administration of the drug was continued until the clinical symptoms had subsided and smears were persistently negative. The

TABLE 2

COMPARISON OF THE AGE OF PATIENTS RECEIVING VARIOUS SULFONAMIDE DRUGS FOR ACUTE GONOCOCCAL CONJUNCTIVITIS

Type of Treatment	Age of Patients						
	Total	Under 1 month		1 month to 12 yrs.		Over 12 years	
		no.	percent	no.	percent	no.	percent
Total	102	71	69.6	21	20.6	10	9.8
Sulfanilamide	28	20	71.4	7	25.0	1	3.6
Sulfanilamide and sulfapyridine	4	3	75.0	1	25.0	0.	
Sulfapyridine	46	31	67.4	10	21.7	5	10.9
Sulfathiazole	8	5	62.5	2	25.0	1	12.5
Sulfadiazene	16	12	75.0	1	6.2	3	18.8

patients were observed for two or more days after treatment was discontinued before they were discharged from the Hospital.

Results

In almost all patients who responded to the sulfonamide drugs, there was a rapid subsidence of the acute inflammatory reaction in the eye, the redness and edema disappearing within two or three days and the discharge stopping in an average of four or five days. However, there were striking differences in the percentage of patients responding to the various drugs, and in the rapidity with which the infecting organisms disappeared from stained films of the eye discharge. Table 3 shows the response of the patients to the various drugs used. There were 32 patients who received sulfanilamide. Of these 6, or 18.8 percent, were resistant to the drug and 26, or 81.2 percent, responded favorably. Only 12, or 37.5 percent, of these patients gave negative smears within three days after treatment was started. Fifty patients were treated with sulfapyridine; of them only 2, or 4 percent, were resistant to therapy, and 48, or 96 percent, responded favorably. Four of the patients who received sulfapyridine had failed to respond to sulfanilamide; one of these was resistant to and three responded to sulfapyridine. Of the 50 patients treated with sulfapyridine, 32, or 64 percent, showed negative smears within three days after treatment was started.

Eight patients were treated with sulfathiazole. All responded to treatment, and six, or 75 percent, had negative smears within three days. Sixteen patients received sulfadiazene therapy; all of them responded favorably, and 12, or 75 percent, showed negative smears within three days. Thus it is seen that on the basis of both frequency and rapidity of cure, sulfapyridine, sulfadiazene, and sulfathiazole are approximately equal, and all are superior to sulfanilamide. Within the first three days, sulfadiazene and sulfapyridine apparently act somewhat more rapidly than sulfathiazole, but our series with the latter drug is too small to make accurate comparison possible.

Further comparisons of the drugs can be made on the basis of the ocular complications that occurred with their use, and the toxic symptoms induced by them. There were no recurrences of gonorrheal conjunctivitis. There was only one corneal ulcer in the whole series. This occurred in a child, aged three years, who was being treated with sulfanilamide. When it appeared, the treatment was changed to sulfapyridine and sterile milk

TABLE 3

COMPARISON OF THE RESPONSE OF PATIENTS WITH ACUTE GONOCOCCAL CONJUNCTIVITIS TO TREATMENT WITH VARIOUS SULFONAMIDE DRUGS

Type of Treatment	Response to Treatment								
	Total	No Response		Favorable Response—Days to Negative Smear					
				Total		Under 3 days		Over 3 Days	
		no.	percent	no.	percent	no.	percent	no.	percent
Sulfanilamide	32	6	18.8	26	81.2	12	37.5	14	43.7
Sulfapyridine	50*	2	4.0	48	96.0	32	64.0	16	32.0
Sulfathiazole	8	0		8	100.0	6	75.0	2	25.0
Sulfadiazene	16	0		16	100.0	12	75.0	4	25.0

* Includes four patients who failed to respond to sulfanilamide.

injections. The conjunctivitis and the corneal ulcer healed rapidly and the child was discharged with only a pinpoint opacity in the cornea. The incidence of corneal ulcer was 1 percent for the total series, 3 percent for the sulfanilamide-treated patients, and zero for all others. In the recent literature the incidence of corneal ulcers in patients treated without sulfonamides has varied from 11.5 percent[7] to 31.2 percent,[6] and has averaged 25 to 30 percent.[2,5]

The toxic symptoms induced by the drugs have not been striking. Slight cyanosis, nausea, and anemia have been encountered frequently, but have not been serious. Of the more severe symptoms, hematuria, drug dermatitis, and hyperpyrexia each occurred once in the group of patients treated with sulfapyridine. There were no severe reactions to sulfanilamide and sulfadiazene, and only one patient responded unfavorably to sulfathiazole. This patient merits special attention:

Case report

J. D., a white male, aged 27 years, was admitted to the contagious-disease service on July 15, 1941. Two days before entry his right eye became swollen and the lids were stuck together by a purulent discharge. The condition became worse until the time of admission. On examination, the eyelids of the right eye were markedly swollen and reddened, both the bulbar and palpebral conjunctivas were injected, and there was a profuse yellow purulent discharge from the eye. The left eye was normal. There was no urethral discharge.

Gram-negative intracellular and extracellular diplococci of typical morphology were demonstrated on stained films of the ocular discharge. These were identified later as *Neisseria intracellularis,* type I. (This organism resembles the gonococcus so closely that the patient may reasonably be included here.)

On admission the patient was given sulfathiazole, 60 grains immediately and 15 grains every four hours by mouth. The following day the blood sulfathiazole level was 10.1 mg. per 100 c.c. The eye showed clinical improvement. Within 48 hours after admission both smears and cultures from the eye became and remained negative for *Neisseria.* The eye continued to show some clinical improvement for five or six days, then regressed rapidly. There was intense injection and edema of the conjunctiva and a moderate discharge. The surrounding tissues were slightly edematous. At the same time, July 22d, seven days after entry, the patient developed a fever of 103°F. (oral). Sulfathiazole was discontinued and on the advice of an ophthalmologist local treatment of the eye was intensified. The following day the temperature and the eye condition were unchanged, but on July 24th the temperature was normal, and the eye was improved. All treatment, both local and general, was then discontinued. The eye improved very rapidly thereafter, and the patient was discharged in good condition on July 29, 1941.

A mild conjunctivitis in patients on sulfathiazole therapy is well known.[8] It occurs with considerable frequency. It was our feeling that the severe reaction encountered with this patient was a marked exaggeration of this well-recognized complication, the exaggeration being due to the already irritated state of the patient's conjunctiva. Since sulfathiazole may cause such severe conjunctival reactions, it should be used in ocular infections only when other equally efficient therapeutic agents are not available.

Several infants, particularly those born prematurely, acquired general infections at the time of or subsequent to the ocular

infections, while they were in the Hospital. There were seven infants in the whole group who died: three had received sulfanilamide, three had received sulfapyridine, and one had received sulfadiazene. In four instances the eyes were clear, and treatment had been discontinued for several days before the onset of the fatal infection. In two instances the secondary infection developed while the therapeutic drugs were being administered, but the evidence at hand points to infection rather than to toxemia from the drug as the cause of death. The final patient, the one who received sulfadiazene, died of congenital anomalies. The mortality among these patients, 7 percent, may seem high. However, almost all the infants who died had been born prematurely. There was no greater loss among these than among other premature infants cared for in the Hospital.

Comment

Several investigators have reported good results in the treatment of gonorrheal conjunctivitis from the local use of various sulfonamide preparations. Thus Rein and Tibbetts[9] report favorably on the results of ocular irrigations with sulfanilamide solution, Panneton[10] had good results from the instillation of sulfanilamide or sulfapyridine powder in the conjunctival sacs, Bruens[11] and Pillat[12] achieved the same end by the frequent local use of a solution of "albucid," a sulfanilamide derivative, and Cecchetto[13] did likewise by applying a suspension of sulfapyridine in warm water to the eyes. Our experience with local treatment has been slight. Several of our patients have had cleansing conjunctival irrigations of an 0.8-percent solution of sulfanilamide simultaneously with orally administered sulfanilamide or sulfapyridine, without obvious added benefit. We have not used local sulfonamide applications alone in this condition.

In the cases reported by Rein and Tibbetts,[9] the best results were obtained in patients who had extraocular gonorrhea and to whom the drug was given both locally and generally. Patients who received local treatment only made much less spectacular responses. In view of this fact, and in view of the fact that we have seen severe drug dermatitis and hyperpyrexia in a patient whose only sulfonamide intake had been from the daily instillation of a 5-percent sulfathiazole ointment into the conjunctiva, we see no advantage to local rather than general sulfonamide therapy.

The results of general sulfonamide therapy in gonococcal conjunctivitis, particularly with sulfapyridine and sulfadiazene, are spectacular. With either of these drugs, 35 percent or more of patients will show negative smears within 24 hours after treatment is instituted, and two thirds or more will be cured within three days. The average duration of treatment with these drugs is less than one week. After the first 24 to 48 hours, irrigations and local applications to the eye usually can be eliminated or greatly reduced. In no instance have we had a normal eye become infected after treatment of the infected eye with these drugs has been instituted. The only protection that we now offer to noninfected eyes is that afforded by postural drainage in infants, and a warning to older patients to avoid touching their eyes with their hands.

There is little to choose between sulfapyridine and sulfadiazene in the treatment of acute gonococcal conjunctivitis. In the general reports on the two drugs, an adequate blood level can be maintained more easily and with less danger of toxic reactions from the administration of sulfadiazene than from sulfapyridine. In our

experience the difference has not been great, however, and has been offset to some extent by the present high cost of sulfadiazene. Larger groups of patients must be treated with both drugs before a final evaluation can be made.

Summary and Conclusions

Between July 1, 1938, and March 31, 1942, there have been 102 patients suffering from acute gonococcal conjunctivitis on the pediatric and contagious-disease wards of the Gallinger Municipal Hospital who have been treated by the oral administration of equal doses of the various sulfonamide drugs. Thirty-two patients received sulfanilamide, with good response to treatment in 26, or 81.2 percent. Fifty patients received sulfapyridine, with good response in 48, or 96 percent. Included in this group were four patients who had failed to respond to sulfanilamide: three of these responded to sulfapyridine. Eight patients were treated with sulfathiazole and 16 with sulfadiazene, all with good response. Only one corneal ulcer developed during the course of treatment; this occurred in a patient receiving sulfanilamide. The ulcer healed promptly when the patient was given sulfapyridine and sterile-milk injections.

Severe toxic reactions were few, and were the same as are usually seen in patients treated with these drugs. The only exception was a severe conjunctival reaction, apparently due to the drug, that occurred in a patient who was being given sulfathiazole.

Sulfanilamide is definitely less effective than are sulfathiazole, sulfapyridine, and sulfadiazene in the treatment of this condition; its use should be discontinued. Sulfathiazole is an effective agent, but because it may be toxic to the conjunctiva its use is not recommended. There is little basis for choice between sulfapyridine and sulfadiazene save that, in general, sulfadiazene is reported to be somewhat less toxic than sulfapyridine.

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NOTES, CASES, INSTRUMENTS

PARINAUD'S OCULOGLANDULAR SYNDROME. TREATMENT WITH SULFATHIAZOLE

WILLIAM O. MARTIN, JR., M.D.
Atlanta, Georgia

In 1889, Parinaud described an infective conjunctivitis, of animal origin, and affecting, as a rule, only one eye. Clinically, it resembled a granular conjunctivitis, with red or yellow granulations, which at first might be transparent, and possibly even ulcerated. The lids were firm, and nodular. He described three cases: In one, the granulations were limited to the superior tarsal conjunctiva, and in the other two there was involvement of the lower lid and bulbar conjunctiva. In all three cases, the cornea was clear. The secretion was mucofibrinous, and at no time purulent. Very early in the disease the parotid region became the site of an inflammatory swelling, which extended to the glands of the neck and was accompanied by a moderate and irregular fever. The disease lasted from a few weeks to many months; and in some cases suppuration of the glands occurred. Parinaud reported no bacteriologic nor pathologic investigations.

The term, Parinaud's conjunctivitis, was suggested by Gifford in 1898. In 1924, Pascheff proposed the term, Parinaud's syndrome, but this term also designates a supranuclear paralysis of associated movements of the eyeballs. Gifford, in 1934, suggested the term, Parinaud's oculoglandular syndrome.

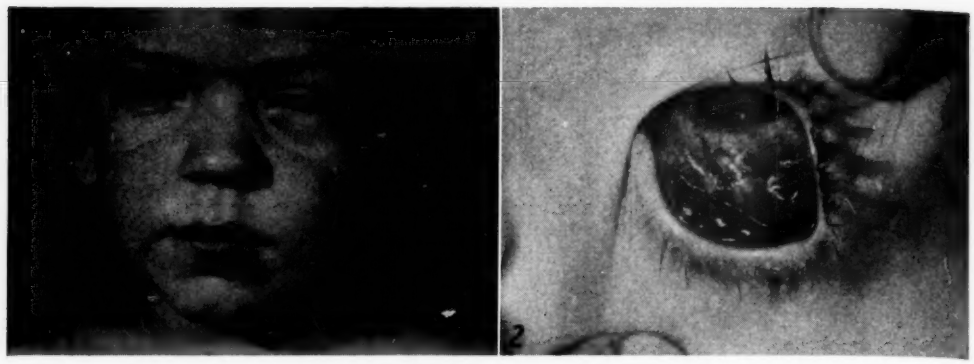
Parinaud's oculoglandular syndrome may include tuberculous conjunctivitis, syphilitic conjunctivitis, tularemic conjunctivitis, leptothrix conjunctivitis, necrotic infectious conjunctivitis, conjunctivitis pseudotubercle rodentum, sporotrichosis, and agricultural conjunctivitis with lymphadenopathy. Smears and cultures may show sporothrix or leptothrix. Guinea-pig inoculation with conjunctival scrapings may show tularemia, tuberculosis, or the organism of necrotic infectious conjunctivitis. Histologic examination may show Leptothrix or tubercles. Wassermann or Kahn test can be made to rule out syphilis. Agglutination test can rule out tularemia. A positive test may be obtained after the first week or 10 days, and may persist for several years.

CASE REPORTS

Case 1. A boy, aged five years, was seen at the request of Dr. W. L. Funkhouser, at Egleston Hospital, on December 24, 1940, because of an inflamed left eye, swelling of the left side of the face and neck, and fever.

The following history was obtained: About 10 days before the eye became red, he had watched someone skin a wild rabbit. It was not definitely known that he touched the rabbit, but it is thought that he did. The left eye became inflamed and "pink eye" was suspected because his little sister had it at the time. There was no secretion nor pain. A conjunctival smear made by his family physician showed no bacteria.

The patient was given neo-silvol eye drops. In four days, the conjunctiva became swollen as did also the preauricular and submaxillary glands. This led his mother to believe he had mumps. At this time, there was a little conjunctival secretion, and he was referred to an ophthalmologist. A diagnosis of tularemia was made, but an agglutination test proved negative. The patient still had no fever. He was given five grains of neo-prontosil every four hours for the first two doses, then 3.8 grains every

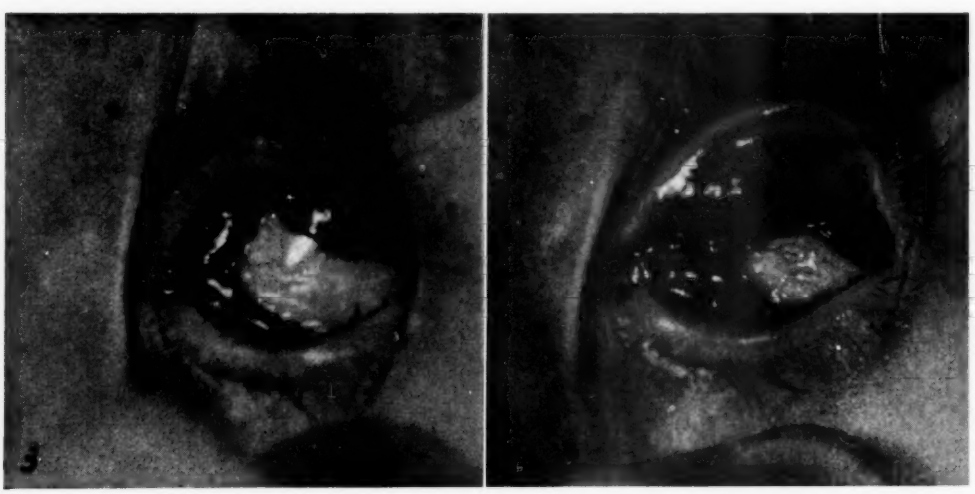


Figs. 1 and 2 (Martin). Appearance of the eye in case 1.

four hours. Two days later, his temperature went to 105.3°. He was brought to Atlanta on December 22d. His temperature varied from normal to 102° and he complained of severe headaches. Agglutination test for tularemia at this time was negative.

About three weeks after his contact with the rabbit, on December 24, 1940, I saw the child and made a diagnosis of Parinaud's oculoglandular syndrome. The right eye appeared to be entirely normal, but the left eye was markedly inflamed. The lids were swollen, the conjunctiva was red and swollen, especially in the lower fornix and plica semilunaris. There were several yellowish-pink nodules on the bulbar and the palpebral conjunctivas (figs. 1 and 2). The cornea was clear. There was a small amount of mucofibrinous secretion, but the conjunctival smears were negative. The parotid and submaxillary glands were quite swollen and firm, but only slightly tender to palpation. The patient was given sulfathiazole grains 7.7 every four hours.

On December 30, 1940, another agglutination test for tularemia was negative, as were also his blood Kahn and Mantoux tuberculin tests. He continued to take sulfathiazole until January 3, 1941, at which time his eye was almost



Figs. 3 and 4 (Martin). Appearance of the eye in case 2.

clear, and most of the glandular swelling gone. On January 8, 1941, the eye was completely clear and the glandular swelling had entirely disappeared.

Case 2. A boy, aged eight years, was seen at Egleston Hospital on January 10, 1941, at the request of Dr. Edward Fincher. He had been sent to Dr. Fincher because of swollen glands and a tumor-like mass in the conjunctiva of the left eye. It was thought this was an orbital or intracranial malignancy. He gave a history of handling a wild-rabbit skin one month before onset of symptoms.

Examination showed a normal right eye. The left eye was inflamed, the conjunctiva thickened, and there were many reddish-yellow nodules in the lower fornix. The plica semilunaris was very red, swollen, and velvety. This had almost the appearance of a lymphoma (figs. 3 and 4). The preauricular and cervical glands on the affected side were markedly swollen, and had been for 12 days.

His blood Wassermann reaction was negative, as was also the Mantoux tuberculin test with P.P.D. No. 2 dilution. Agglutination test for tularemia was negative. Conjunctival smears were negative.

The patient was given sulfathiazole grains 7.7 four times a day. His eye had cleared and the glandular enlargement disappeared within 10 days.

Summary

Two cases of Parinaud's oculoglandular syndrome are reported. They both came from the same locality and were seen within a few days of each other. Both children, presumably, had handled a rabbit within a month of the onset of symptoms. In my opinion, the course and duration of the disease were greatly influenced by the administration of sulfathiazole; however, the condition might have cleared up just as quickly without it.

422 W. W. Orr Doctors Building.

CONGENITAL MYOPIC ASTIGMATISM IN IDENTICAL TWINS

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E. T. Carey, M.D.
Davenport, Iowa

This case, one of compound myopic astigmatism of high degree in monozygotic female twins, three years of age, is presented because of the similarity in kind and amount of the refractive error in each twin.

These twin girls were first seen in our office on February 2, 1942. During the previous week the parents had first noticed that the eyes of twin "B" turned in. This was only noticeable while the child was eating—the eyes converging as each spoonful of food was brought to the mouth. However, for some months past the parents had noticed that the twins held objects very close to the face while looking at them.

Except for the chicken pox, in December, 1941, the past medical history was essentially negative. They were born January 12, 1939. The pregnancy was full term, delivery spontaneous, and nothing occurred during the pregnancy which could be considered as having any possible influence on their development. Twin "A" was born first, and weighed 5 pounds, 2 ounces; twin "B," born 20 minutes later, weighed 5 pounds, 10 ounces.

Development to date has not been unusual. They began to sit up, crawl, talk, and walk at about the same time and within normal limits. Their personalities are said to be similar; both are energetic, talkative, and friendly, and they have similar likes and dislikes. Their present weight is 30 pounds, and their height 36 inches.

There is no known familial disease nor deformity nor are there developmental defects, nor is there any history of

nearsightedness in the family. Both the father and mother are alive and well, neither wears glasses; both possess 20/20 vision in each eye. On the father's side there are seven siblings, none of whom wears glasses. There is one other child in the family, a six-year-old sister of the twins, who is in good health and possesses 20/20 vision without correction.

Data for twin "A." Vision was undetermined. The lids, conjunctiva, and tear sacs were normal; the pupils round, active, and equal. The irides were blue and not remarkable. Ocular tension was normal; ocular rotation normal; PD—49 mm. The media were clear. On examining the fundus a generalized thinning of the retina was found, the choroidal vessels showing through. The blood vessels of the retina entered and left through the nasal half of the disc.

Retinoscopy findings under atropine cycloplegia were: O.D. −10.00D. sph. ⌯ −1.00D. cyl. ax. 80°; O.S. −11.00 D. sph. ⌯ −1.25D. cyl. ax. 90°.

Data for twin "B." Vision was undetermined. The lids, conjunctiva, and tear sacs were normal. The pupils were round, active, and equal; the media transparent throughout. Ocular rotations were normal. The irides blue and not remarkable. The eyegrounds were of the blond type. There was a generalized thinning of the retina through which the choroidal vessels were visible.

Retinoscopy findings under atropine cycloplegia were: O.D. −10.00D. sph. ⌯ −1.25D. cyl. ax. 90°; O.S. −10.50 D. sph. ⌯ −1.25D. cyl. ax. 90°.

Treatment consisted of cycloplegic refraction, lens correction, and advice on exercise, diet, and so forth. Adrenalin (1:1,000) was prescribed, one drop to be instilled three times daily. Periodic follow-up examinations were made.

Marks of ocular similarity especially noteworthy in this case of identical twins, are the size and disposition of the lids, the shape and size of the palpebral fissures, the density and direction of the hair of the eyebrows and eyelashes, the shape and size of the disc, the color and generalized thinning out of the retina, in addition to the similarity in the type and degree of the refractive error in the corresponding eyes.

70 Kahl Building.

PULSATING EXOPHTHALMOS*

A CASE REPORT

FRANK H. MAYFIELD, M.D.
Cincinnati, Ohio

Many different procedures have been used in the treatment of pulsating exophthalmos from carotid-artery–cavernous-sinus fistulas. Ligation of the common carotid artery or the internal carotid artery on the side involved has been used most often, and frequently many procedures have been necessary on the same patient. It has been well proved that, following ligation of the common carotid artery, there is a reversal of blood flow from the external into the internal carotid. It is also well known that, following ligation of the internal carotid artery, the collateral circulation through the external carotid artery develops rapidly. Because of this, Reid[1] has long maintained that occlusion of both the common carotid and the external carotid on the side involved should be effected simultaneously. This case is reported because it supports that opinion.

H. S., a white man, aged 35 years, was admitted to the St. Elizabeth Hospital, in Covington, Kentucky, on September 28, 1937. On admission, there was advanced

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* Presented before the Society of Clinical Surgeons meeting in Cincinnati, Ohio, April 3-4, 1942.

pulsating exophthalmos of the right eye, and the patient was complaining of roaring sounds in the right side of his head. His illness had begun two months before, without trauma. His first symptom was a sudden severe attack of pain which involved chiefly the right frontal and suboccipital regions. Two days after the onset of the pain, he was suddenly aware of a loud, roaring sound that, for the most part, seemed to be on the right side of his head. The severe pain which had been present at the onset subsided after five days. Two weeks prior to admission, his right eye had begun to swell. This was followed in rapid succession by the development of diplopia, and then by failing vision in the right eye.

Examination revealed a well-developed, well-nourished man, whose general appearance was not especially remarkable except for moderately advanced proptosis of the right eye (fig. 1). The eye protruded considerably and there was pulsation of all the orbital structures. There was moderate edema of the eyelids and of the conjunctiva. A loud bruit could be heard over the entire right side of the head. This was most distinct about the right eye. There was limitation of motion of the eye in all directions, and there was moderate papilledema on the right.

With compression of the common carotid artery on the right side, the pulsation of the eye would cease, and the bruit would become almost imperceptible. Compression of the left common carotid artery did not affect the pulsation of the eye nor the bruit.

The blood Wassermann test was negative. X-ray studies of the skull were normal.

Exercises by digital compression of the right common carotid artery were begun, and repeated several times daily for a period of 10 days. The patient would then tolerate compression of the right common carotid artery for 20 to 30 minutes without discomfort.

Operation. On October 11, 1937, the right common carotid artery was exposed in the neck and occluded for 30 minutes with a rubber-shod clamp. At the end of this time, there had been no symptoms of cerebral ischemia, so the vessel was ligated, using two ligatures of braided silk. Following this procedure, the exophthalmos was less marked, and the bruit greatly reduced. For a few days the pulsation was not visible. After three days, however, the pulsation was again apparent, and the proptosis appeared to be increasing.

Fig. 1 (Mayfield). Appearance of patient prior to operation, showing proptosis and ptosis of right lid.

On October 26th, fifteen days after the common carotid artery had been ligated, the wound was reopened and the external carotid artery ligated. The ligatures that had been placed on the common carotid artery seemed to be holding well, and this vessel appeared to be completely occluded. The internal and external carotid arteries, however, appeared about as large as usual, and there was a good pulse through them. The external carotid artery was occluded by two ligatures of braided silk.

When the patient returned to his room following this procedure, the pulsation of the eye had ceased. Within three days all swelling had disappeared. A faint bruit was still audible in the right temporal area, but was no longer continuous and came only with the pulse. Six weeks

after this operation all signs of proptosis were still absent, and the function of the extraocular muscles was normal. On December 5th, 40 days after the external carotid artery had been ligated, the supra-

Fig. 2 (Mayfield). Appearance of patient four years after operation.

orbital vein was exposed and thrombosed, in an effort to obliterate the bruit. No improvement was obtained. The patient has now been observed for a period of four years. When last seen on April 1, 1942, he was working regularly as a laborer. There was no evidence of exophthalmos (fig. 2). He was still conscious of a noise in his head, and the bruit was audible in the right temporal area.

Comment. The fistula in this case presumably developed from a spontaneous rupture of an aneurysm of the internal carotid artery into the cavernous sinus. Efforts to correct such a fistula are comprised essentially of attempts to reduce the blood flow through the fistula sufficiently to permit development of the thrombus which would occlude it. Because of the rapid reversal of blood flow from the external into the internal carotid artery after ligation of the common carotid, and because of the rapid development of collateral circulation following ligation of the internal carotid artery, it seems advisable to ligate both the common and external carotid arteries at the same time. The case reported here supports that opinion.

Reference

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SOCIETY PROCEEDINGS

EDITED BY DR. RALPH H. MILLER

CHICAGO OPHTHALMOLOGICAL SOCIETY

October 27, 1941

DR. SANFORD GIFFORD, *president*

CLINICAL MEETING

(Presented by Illinois Eye and Ear Infirmary staff)

BOECK'S SARCOID

DR. GEORGE T. ALLIBAND said that the patient, E. A., a woman aged 31 years, was first seen in June, 1936, because of intermittent photophobia, redness, and pain in the right eye of four months' duration. The findings were those of subacute iritis with no specific etiology. Vision, R.E. 20/25; L.E. 20/15. Tension was normal in each eye. Under local therapy there was a gradual rise of intraocular pressure, which was controlled when the patient was hospitalized. Upon discharge the diagnosis was subacute uveitis, etiology unknown, and secondary glaucoma.

The patient was kept under observation in the out-patient department, and in July, 1939, was again hospitalized. All laboratory tests gave negative results. X-ray studies of the chest showed shadows of the bases and hilar regions suggestive of some nonspecific type of infection. There was a cervical-gland enlargement for which no cause could be found. Vision was R.E. 20/50, L.E. 20/20, and tension was normal. The eye again became quiescent and remained so until March, 1941. Following a course of tuberculin therapy, the patient noticed subcutaneous nodules on the arms and upper trunk, which, by August, 1941, had become so noticeable that the diagnosis of Boeck's sarcoid was suspected. This was confirmed by biopsy studies made at Northwestern University and Phipps Institute.

At present the corrected vision is R.E. 20/200; L.E. 20/20. Tension R.E. 26; L.E. 13. A subcutaneous nodule 1 by 1 mm. in size was found at the inner extremity of the right brow. The conjunctiva is congested, with granular follicular hypertrophy. The cornea showed injection with a sclerosing process around the limbus. The anterior chamber was of average depth. The pupil dilated to 8 mm., with two large posterior synechias at the 4:00- and the 5:00-o'clock positions. There was scattered pigment deposition along the pupillary border and anterior surface of the lens. With the ophthalmoscope fine floating vitreous opacities were observed; the disc was flat. Gonioscopic examination showed many dense trabecular adhesions throughout the angles. Several definite nodules were observed in these adhesions. Many flocculent adhesions were seen on the posterior corneal surface.

General physical examination revealed woody swelling and enlargement of parotid glands; numerous subcutaneous nodules over the upper forearms, back, and legs; inguinal adenopathy. X-ray studies showed multiple, variable-sized infiltrations of both lung fields, suggestive of a hematogenously disseminated process. There was no evidence of pathologic bone changes. The present treatment consists of nonspecific therapy for the subacute uveitis.

SUBCONJUNCTIVAL FOREIGN BODY

DR. GEORGE T. ALLIBAND said that this 13-year-old boy was seen first on September 14, 1941, because of pain in

the left supraorbital region following a blow to the eye. Vision R.E. 20/20; L.E. 10/200. Tension was normal. The left eye showed marked bulbar chemosis and injection, with blepharospasm. In spite of treatment there was no improvement of the traumatic iritis, and on October 4, 1941, examination showed contraction of the pupil and intense congestion of the conjunctiva, with a small prominence visible behind the limbus. An X-ray study showed a metallic foreign body 10 by 0.5 mm. in size, 4 mm. behind the limbus at 35 degrees. This was surgically removed. At this time the flap area is well attached. The pupillary border of the iris is visible in the region of the injury but remains retracted. The iris is somewhat swollen. The scleral prominence is now flat with some pigment discoloration beneath the conjunctiva. Vision, R.E. 20/20; L.E. 20/70 + 2.

Congenital syphilitic chorioretinitis: choked discs

Dr. B. K. Williamson presented G. M., a boy aged 10 years, with a history of poor vision of unknown duration, and backwardness in school. The essential eye findings were bilateral choked discs with early atrophy (the left disc measured 3 to 4 diopters); bilateral salt and pepper fundi; corrected vision of R.E. 20/200; L.E. 20/50. The blood Wassermann test was negative, the spinal Wassermann 3+; Pandy 2+; cells 14; Lange, tabetic curve. The ocular pressure was grossly normal.

Traumatic aniridia

Dr. B. K. Williamson said that S. L., 72 years old, while undergoing operation for removal of cataract in the left eye, suddenly moved his eye downward as the iris was grasped by the surgeon. A total aniridia resulted. At this time, five weeks later, the patient complains of photophobia. Tension is normal; the fundus is normal. Corrected vision, L.E., is 20/50.

Corneal dystrophy

Dr. R. E. Flatley presented E. L., a man aged 39 years, who complained of having had poor vision for near work for the past five years. Vision R.E. is 20/70. The left eye is blind as the result of a perforating injury many years ago. Slitlamp examination disclosed many snow-white, highly refractile, irregularly shaped masses throughout the stroma of the right eye. The region around the limbus is clear. The cornea between the spots is clear.

Atypical juvenile macular degeneration

Dr. R. E. Flatley said that this 12-year-old boy gave a history of inability to read print. Upon examination the maximum vision obtained was R.E. 20/200; L.E. 10/200. The blue peripheral field showed a slight constriction in the left eye, using a 5-mm. target; the central blue field was not taken because of difficulty in fixation. No macular reflex was elicited. The pigment in the macula appeared to be coarser than normal, and the macula was spread over a larger than normal area.

Cicatricial ectropion with plastic repair

Dr. J. J. Sitney presented a 23-year-old man who had been severely burned about the head and face in November, 1940. There was marked scarring of the scalp and face, and marked ectropion of both upper lids, with the lid margins drawn up into the brow region. The lashes were intact. There was a small ectropion of the right lower lid. The cornea of the right eye showed a dense, extensive adherent leucoma; a smaller

leucoma was present in the cornea of the left eye. Vision, R.E., was light perception; L.E. 20/200, corrected to 20/50.

Four weeks ago, plastic repair was performed on the left upper lid. The lid was dissected free from the scar and sutured to the cheek. A Thiersch graft, taken from the arm, was applied, and the eye left undisturbed for four days. Two weeks later a similar procedure was carried out on the right upper lid. At the present time there is good movement and approximation on the left side, but the right still shows incomplete approximation, and further work is contemplated. Wheeler adhesions will be made between the upper and lower lids to prevent further contracture.

Retraction syndrome

Dr. Katharine H. Chapman said that J. P., a 13-year-old boy, was brought to the clinic because of occasional crossing of one eye. On examination the characteristic findings of the retraction syndrome described by Duane were found, as follows: Abduction of the left eye was absent; adduction was somewhat limited; narrowing of the palpebral fissure occurred on adducting the left eye and widening on abducting; retraction of the left eye into the orbit when looking to the right; upshoot of the left eye when looking to the right; remote near point of convergence.

In the primary position the eyes were straight. There was only a slight refractive error. On the synoptophore there was good fusion, and no diplopia was present.

Embolism of central artery

Dr. Walter Ackerman said that this 17-year-old girl gave a history of having suddenly become blind in the left eye one day ago. There was a past history of chorea with involvement of the mitral valve. Examination showed the usual appearance of the occlusion of the central artery, with pallor of the disc, disc outline blurred, and the entire retina pale except for a cherry-red spot in the macular region. There was very little blood in any of the arteries.

A posterior sclerotomy was immediately performed, followed by massage of the eyeball and retrobulbar injection of 2 minims of 20-percent mecholyl. This was repeated twice on the following two days without improvement of the fundus picture or any return of vision.

Kodachrome clinic

The photography of ocular melanosis

Dr. Robert Von der Heydt presented a paper on this subject.

Photographic records of ocular melanosis are of great value and importance. They enable us to make an accurate comparative study of melanotic areas in respect to a determination of their progression. They give a definite picture, making possible an accurate measurement if progressive changes are found and are also a means of evaluating their character. The time element in which changes may occur will be disclosed. A more accurate knowledge of how often and in what manner a heretofore presumed benign ocular melanoma may develop malignancy may ultimately be acquired. What are the characteristics of this metamorphosis into malignancy? A better understanding may tend entirely to eliminate the so-common inclination to dangerous removal of part of the tissue for the purpose of diagnosis (biopsy).

Progression of lesions may be accurately depicted by dated serial photographs. Also the efficacy of irradiation treatment can be shown. Patients with melanotic eye lesions and melanomata should be in possession of dated pictures and the scale of their magnification.

Whether surgery, surgery irradiation,

or the latter alone should be employed must naturally vary in individual cases.

The important question unfortunately remains, when and because of what is a lesion malignant? An analysis of color photographs showing vascularization, if present, may be a factor in this determination. A few of these serial sets are halves of black-and-white stereoscopic pictures dating from a decade preceding 1936. In 1936 kodachrome became available and it has revolutionized clinical photography.

Forty slides were presented, among which there were examples of melanotic lesions on various parts of the eyeball, lid, and fundus. Some were small and a few showed a probable metamorphosis into malignancy.

Serial pictures were shown depicting increase in the size of melanotic areas over a period of time. Many sets graphically presented the astounding results of irradiation treatments. Unfortunately some of these patients developed delayed cataracts.

A case of iris sarcoma still limited to the sphincter area was shown. It was removed by a large iridectomy. There has been neither ocular metastasis nor relapse in eight years.

A picture of essential atrophy of the iris showing two areas of the pigment layer of the iris was shown as being of interest in differential diagnosis. A small hole in the pigment area, iris atrophy, and glaucomatous changes of the cornea confirmed the diagnosis of essential iris atrophy.

Fundus kodachromes were shown presenting various types of melanosis, as well as a large series of small lesions strongly suggesting suspicious sarcomata.

Discussion. Dr. Beulah Cushman congratulated Dr. Von der Heydt on this beautiful collection and felt the Society was fortunate in seeing these pictures. She presented slides from three patients. The first, a 10-year-old girl with a melanoma of the limbus, had been treated with small doses of X ray at frequent intervals; a second picture, taken a year later, showed the melanoma better defined and smaller.

The second patient, a Japanese medical student, had had a pigmented spot on the limbus as long as he could remember. It was removed when it showed some increase in size, and on biopsy study a diagnosis of malignant melanoma was made. The first kodachrome slide showed the pigmented area on the limbus extending into the cornea; the second slide, with higher magnification, showed the nests of large nevi cells between the epithelial downgrowths, and pigment around the edges of the large cells with malignant tendencies. The pigmented cells had penetrated between the corneal fibers.

The third patient, a young woman, had a history of being struck in the eye by a firecracker at the age of 13 years. A black spot in the eye began to enlarge about two years before the eye was removed, when she was 24 years of age. At that time there was a pigmented tumor below the limbus, 3 by 10 mm. in size, elevated 3 mm. The lower half of the cornea was irregular and thick, as was the iris. The limbus was elevated and the sclera was penetrated by the mass. The posterior part of the eye was clear.

The pictures showed cross sections of the globe with a malignant melanoma extending through the sclera into the iris and cornea. Four years following enucleation, there was no evidence of local recurrence or general metastases.

What value has orthoptic exercise in the treatment of strabismus and related conditions?

Dr. Mary Jane Fowler presented a

paper on this subject, summarized as follows:

I. CONVERGENT SQUINT

A. Accommodative (45 cases)

1. Eyes were straight with glasses. (Full atropine correction worn all the time.) Forty-four percent of patients "outgrew" manifest squint unaided for distance and near at 6½ to 8 years of age after this therapy.

2. Ninety percent had fusion, wth low range of 21 prism diopters, and 40-percent stereopsis. In these cases, orthoptic exercises were indicated.

3. Total occlusion of the stronger eye for a six months' minimum was found necessary until the vision of the weaker eye equalled the vision of the better eye. Vision of each eye was checked every four weeks.

4. Surgery was contraindicated.

B. Nonaccommodative (116 cases)

1. Convergence was still present with glasses on. After six months of wear of full atropine correction, the convergence decreased 6 to 10 degrees for distance and near.

2. Eighty percent of patients had abnormal retinal correspondence; 20 percent had low range of fusion and no stereopsis. Orthoptic exercises were contraindicated.

3. Total occlusion of the stronger eye for a six months' minimum until vision of the weaker eye equalled vision of the stronger eye. Then alternating occlusion (1:1, 1:2, 1:3 ratio) was carried out until surgery was done. Visual acuity of each eye was checked every four to six weeks.

4. Surgery was considered indicated at four years of age.

II. DIVERGENT SQUINT (21 CASES)

1. Eighty percent were cases of monocular squint, with compound hyperopic astigmatism. Thirty-three percent of patients had anisometropia, and the deviating eye had the higher refractive error. Glasses were considered to be contraindicated except in myopia and anisometropia.

2. Fifty percent of the patients had a low range of fusion (only two had stereopsis). Orthoptic-exercise trial was indicated preoperatively and postoperatively.

3. Vertical-prism hanger was indicated for correction of any hypertropia during orthoptic training.

4. Surgery was indicated as a last resort for eyes having fusion, but indicated any time in those having abnormal retinal correspondence.

NOTE: Amblyopia and blunted vision were improved 20 percent after six months of total occlusion of the better eye in 35 cases of strabismus.

Discussion. Dr. E. V. L. Brown mentioned that Dr. Fowler finds wide-going limitations to orthoptic training; that is, fusion training. First, retinal correspondence must be present; that is, the objective- and subjective-squint angle must be the same on the synoptoscope or within 5 degrees of each other. These angles can be properly measured only on a synoptoscope, synoptophore, orthoscope, or some similar costly instrument. Then, too, this cannot be carried out in some 10 percent of cases (18 of 182 in Dr. Fowler's series) because patients are too young. Moreover, retinal correspondence is lacking in the majority of cases (94 of 164, or 57 percent, in Dr. Fowler's series) and no fusion can be developed. Further evaluation of exercises therefore simmers down to 70 cases (about half of the original 164) with known, proved, retinal correspondence. And here, with normal retinal correspondence present, Dr. Fowler finds that no amount of fusion training, even under the most favorable circumstances, will improve fusion more than 10 prism degrees. Ten of these cases

were postoperative; 60 were cared for on a nonoperative basis. This 10-prism-degree improvement obtainable is insignificant. Most squints have to have more correction than this or patients are dissatisfied. He had great confidence in Dr. Fowler's work and the validity of her conclusion—for example, that orthoptic training (fusion training) is without value in the treatment of squint either before or after operation—but the synoptoscope is necessary to determine retinal correspondence.

Dr. Katharine Chapman felt it was difficult to discuss treatment of the usual concomitant squint by orthoptic training without considering the manner in which such a squint develops. No muscular coordination in the body is so closely limited by another function as are the eye movements by the act of seeing; the eyes cannot be moved independently of the visual impressions.

Fixation is not present at birth, nor is the reflex of the fusion movement, but both are established early; the convergence movement comes still later. A convergent squint develops early, while eye movements and other coördinations are being learned. Many unnecessary muscles are contracted with the effective ones in learning coördination, and only with repetition are impulses sent only to the needed muscles while the antagonists are relaxed. When convergence is being learned, excessive impulses are sent to the convergence center, and divergence, which is probably a relaxation, does not take place. Because of the dependence of vision on the position of the eyes, a diplopia develops on overconvergence, which is disturbing, and suppression is learned as a protection.

Any disturbance of coördination, fatigue, illness, or fear, may cause an overflow of stimuli and resulting convergence. A hyperopia necessitating constant accommodation may cause overflow of stimuli and a resulting convergence or may stimulate convergence that is not accurate in amount. Anisometropia or aniseikonia may lead to suppression and convergence. Add to this the special vulnerability of the sixth nerve, which might cause temporary weakness of the external recti, and it is strange that many more children do not develop convergent strabismus.

Once coördination of the ocular movements is established, convergent strabismus does not develop. But while in the fluid stage any of these factors may cause increase in the bad habits of binocular vision which relieve visual confusion. Establishment of these habits causes diminution of the desire to straighten the eyes and develop binocular single vision. These bad habits are alternation, suppression, and development of anomalous correspondence. If reëducation is started early and binocular vision is prevented except during training periods, it is possible to change the anomalous correspondence, and when this is corrected, the patient should be operated on or an attempt should be made to diverge the visual axes.

Disassociation of convergence and accommodation and full correction of refractive errors helps in certain cases to accomplish divergence. It is difficult to study the ability to develop the divergence movement. Cantonet and Fillozat have had good results in persons past the age of 14 years, who will give intelligent coöperation. This has also been successful here in some intelligent and persistent patients.

A third means of developing divergence is the reflex that brings the two eyes automatically to fixate on the same object. This reflex is not present at birth, but has been found in some infants at the age of six months. If, during a period of

five or six years, the two maculas are not used together, one would expect this reflex to be below normal. It has been found that it can be increased, and if the visual axes are made parallel, becomes normal.

It is important that the patient be sent to operation at the proper time. Improvement of general health is important. Complete occlusion is an essential part of treatment both of amblyopia and of anomalous correspondence. A patch of gauze and adhesive on the face is the most effective means of occlusion.

Amblyopia ex anopsia can, with proper coöperation, be improved in patients of almost any age. In young patients, it readily improves to normal with complete occlusion if the child really uses the eye. If there is a central scotoma, due to destruction of nervous pathways, there will, of course, be no improvement. It has been found that distance vision does not improve at first, but near vision does.

Dr. George Guibor felt that Dr. Fowler should be complimented on this excellent work concerning a problem that is controversial at the present time. He agreed that fusion training without supportive measures such as atropine and prisms is of little value in the treatment of strabismus. Worth has emphasized fusion training and the use of atropine cycloplegia. Atropine is used to relax the spastic accommodation that is so frequent in patients having convergent squint, who are wearing strong convex lenses. With atropine the spastic accommodation is relaxed and, indirectly, the spastic convergence is relaxed.

If one believes that improvement in the strabismus is evidence of partial recovery, then approximately 50 percent of patients will recover by nonsurgical means—a cosmetic recovery, according to Chavasse. However, if one chooses fusion ability as an indication of recovery, one finds few patients who recover. There is no true yardstick by which we can measure normal fusion ability. Bielschowsky has said that fusion ability varies from day to day in the same individual, as well as in different individuals. Therefore, if one chooses such a variable criterion as fusion ability alone, few patients will show any evidence of recovery because there is no constant fusion but a variable fusion. With the exception that he believed that atropine and prisms should be used with fusion, and that one should regard an improvement of deviation as evidence of recovery, he agreed thoroughly with the conclusions presented by Dr. Fowler.

Dr. Vernon Leech said that Dr. Fowler implied that total occlusion of the good eye or fixating eye for several months would bring about lowered visual acuity. He wondered whether she had any statistics to show how much visual loss there would be and how long it would take the occluded eye to come back to normal after occlusion had been discontinued. In some cases in which he had used occlusion for six months or longer at a stretch, without alternating the occlusion, he had noted no permanent deterioration in vision in children old enough to respond accurately to vision tests.

Dr. George E. Park did not agree with the definition of abnormal retinal correspondence. False projection, which is spoken of in the literature, may be either a false or a true projection, depending upon the homeostatic balance of the individual's neuromuscular system at the time. Abnormal retinal correspondence assumes an exact retinal point-to-point relationship. Projection and retinal point-to-point relationship are two distinct problems until they are separated. To speak of abnormal retinal correspondence is confusing.

In measuring abnormal retinal correspondence on the synoptoscope, the position of the eye is taken, and the angle of

projection of the image is observed. The angle between the optic axes of the eye and the visual axes is the issue, and when the angle of projection is measured, it is a variable angle. One cannot say the angle of projection remains constant. Many of these cases are fast alternaters, and this requires close scrutiny to determine how the eyes are functioning.

Amblyopia is a confusing term. If it is understood as a condition within the eye that prevents improvement of vision, it is acceptable. But in an eye that has been crossed for some time, in which the patient has learned to suppress the image, but in which vision can be improved by refraction—that is not amblyopia but suppression.

There is certainly a place for orthoptic training before and after surgery, but children should be under strict supervision or else it is a waste of time. So far as occlusion is concerned, the primary interest is to have both eyes functioning simultaneously, and if one is occluded the purpose is defeated. If vision is good the eyes can usually be made to fuse by using atropine in the fixating eye, or even in both eyes concurrently.

Dr. Thomas D. Allen asked, in view of the fact that Dr. Fowler was rather disappointed with the results in orthoptic training, how she defined orthoptic training? Is it simply the use of the stereoscope at home and in the office, or does she include the use of the synoptoscope?

Dr. Mary Jane Fowler in closing said that one child was given fusion training exercises at home and in the clinic. When the synoptoscope was used, she gave peculiar answers, and abnormal retinal correspondence was found. She was given 20 preoperative and 20 postoperative synoptoscope exercises, but the abnormal correspondence remained.

Glasses were ordered while the atropine was still effective, usually within 10 days. If glasses were not given for 10 to 15 days, the cycloplegia would have disappeared. If the refractive findings are not satisfactory a second course of atropine is given, and the patient will gradually adjust to full atropine-correction glasses. In cases of accommodative squint, history of recent illness is important.

In reply to Dr. Leech's question, in one patient about 18 months old, the left eye was occluded. She did not return to the clinic for three months, and it was found that the left eye was amblyopic; it did not return to normal, although occlusion therapy was initiated. The patient finally underwent an operation. Vision is checked in each eye after five or six weeks of occlusion. In another child about 10 years old, the vision within four weeks dropped in the occluded eye from 20/20 to 20/30, but when occlusion was discontinued vision returned to normal.

Amblyopia is defined as 1/10 Snellen, 20/200 or less. Anything above 20/200 is called blunted vision. Occlusion treatment is entirely separate from fusion training. Stereoscope exercises are not given at home, but under supervision in the clinic. Orthoptic training has been disappointing in the clinic, and it is felt that the patient does not coöperate in home training.

Robert Von der Heydt.

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EDWARD JACKSON, M.D.
1856-1942

Today, as the Journal goes to press, the sad news of the death on October 29th, of Dr. Edward Jackson, dean of ophthalmologists in America, reached the editor. Time and space will permit only of this brief notice. In the January issue his obituary will be published, and the editorial pages will be given over to personal sketches of the originator of the Journal in its present form; at a later date an announcement will be made of some fitting memorial of Dr. Jackson by the Journal.

Here we may express only our feeling of great loss in Dr. Jackson's death. For 24 years he was the moving spirit of the American Journal of Ophthalmology, and the respect, admiration, and affection of the ophthalmologists of the world for him has been the most important single factor in the Journal's success through the years. Editor-in-chief for its first decade, and active contributor since then, his counsel has always been sought in all matters of importance by the succeeding editors and directors. His leadership will be greatly missed, and he leaves an empty place in the hearts of those who have been privileged to work with him.

Lawrence T. Post.

* Deceased.

HURLER'S DISEASE OR DEFORMITY

Words take their meaning from the purposes for which they are used. But words in common use have distinct and

differing meanings, which should be definite and not easily confused. Under the title, "Dysostosis multiplex (Hurler's disease; Lipochondrodysplasia; Gargoylism)," F. C. Cordes and M. J. Hogan, of San Francisco, report the ocular findings in five cases of a rare condition, first described by C. Hunter 25 years ago. Two years later G. Hurler, in a German periodical describing it as a disease of children, it became known as Hurler's disease. Now there have been 41 descriptions of it added to the literature. It appears to be very definitely a congenital abnormality, giving rise to a characteristic deformity. Only by the broadest and most vague use of the word, can it be called a "disease." One writer has described it as "familial and genotypical." Perhaps the best name for it is "gargoylism."

The appearance that first attracts attention is usually the lateral displacement of the eyes, which seem to be very wide apart. Later X-ray examinations show abnormal development in bones and cartilages throughout the body. Haziness or clouding of the cornea has been found in more than 75 percent of the cases; although in the first two reported cases no corneal involvement was noted. In two cases the corneal cloudiness was noticed at birth, and in most cases it appeared before the third year of life. In all cases the eyes appear larger than normal for the child's face. Abnormality of appearance has been noticed, usually at the age of one year; and nearly all the 50 children whose cases have been reported have died before the age of 20 years.

Recognition of the ocular symptoms seems to be the first indication of this important abnormality of development. On this account the ophthalmologist should be alive to the significance of what he observes in the condition of the child. The parents' theory of the nature and cause of the trouble may be fantastic and absurd. It seems probable that many children affected by this deformity have died without its congenital origin and importance having been recognized. Now that it has been brought to the attention of ophthalmologists it is likely to be more frequently recognized and reported than the scanty previous literature regarding it might lead us to expect.

The appearance of an enlarged eyeball, and the haziness of the media, might give the impression that the case was one of buphthalmos. But the dimensions given in the reported cases show no actual enlargement of the globe, and the tonometric measurements indicate it is not related to juvenile glaucoma. It seems to be a distinct, congenital tendency of general development in the whole body. The roentgen-ray pictures show anomalies of both bone and cartilage throughout the body and limbs. The reported cases have generally shown umbilical hernia. Lipid infiltration of the central nervous system is looked upon as a cause of failure in mental development. It must be regarded as a special form of "dwarfism"; and the early death is clearly an essential character of this pathologic condition. It may be more common than the present statistics would indicate. The recognition of its special characteristics should bring reports of additional cases.

Edward Jackson.

SELF-TRAINING IN REFRACTION

How to do things is ordinarily better taught by personal demonstration than by use of the printed page. The modern method of cinematographic demonstration is an outgrowth of the personal method of instruction, broadened in its scope through a great invention.

Yet it is well to supplement personal

demonstration with deliberate reading of good descriptions. Written instruction, particularly when enriched by illustrations which do not hurry away before we have had time to become sufficiently acquainted with them, gives us its own characteristic opportunity for complete assimilation.

Some students are either actually lacking in ability to visualize a written description, or have not learned how to apply themselves adequately to the process of absorbing, step by step, the explanation given in a book or journal. Some authors are much less facile than others in producing a mental image by the use of language. But the fault often lies with the hasty or careless reader, who does not concentrate sufficiently on each individual detail of the description.

The technique of measuring the refraction of the human eye, so far as it is taught at all, is more generally taught by word of mouth, and by watching others work in the office or clinic, than through printed description. Yet it might be better for every student of refraction if, in addition to demonstrations of physiologic optics, he were compelled to show thorough acquaintance with a textbook, or textbooks, on the subject.

The learning of refraction work through listening to an instructor, and by watching tests made on patients in the clinic, is capable of leaving in the student's mind important gaps which his later personal experience does not fill. Careful and repeated preliminary reading can in large measure avoid the existence of such gaps, and will round out the beginner's understanding of individual cases as illustrating general principle.

It is possible for an apt and diligent student to master refraction technique, at least for the more straightforward type of case, through reading a good textbook and without any oral instruction. It will be necessary for such a student to do a good deal of further thinking as he encounters unusual cases. But this is true after any sort of teaching in refraction.

We have been told at times about the possibility of teaching an intelligent high-school graduate how to measure refraction. But the mere learning of a set of rules does not take care of the more obscure and exacting problems which are rather frequently encountered in daily practice. To deal with these the refractionist must for ever retain the open mind of the research worker. In such cases the physician, with his training in the whole field of medical knowledge, is much better qualified to think analytically and constructively than any lay technician, or even a graduate from the optometric department of a great university.

Direct personal experience is often the most effective teacher. An eminent clinician, now departed, used to say that he would never administer to a patient a drug whose action he had not tested on himself. The worker in refraction ought to be thoroughly familiar with his own reactions to the tests which he uses on others. He is perhaps fortunate if he is himself the victim of a complicated refractive error. Even though he does not prescribe for himself he ought to go as far as possible in measuring his own refraction. If (perhaps unfortunately, in this relationship) he is emmetropic, he should make himself ametropic with lenses, including an element of astigmatism, and should then apply various tests to his own eyes.

Rules are often "made to be broken." In some parts of the world one has heard of a rule that an astigmatic error of not more than a half diopter should be disregarded; but most American ophthalmologists have proved the fallacy of such a rule again and again. Some workers set a fixed age limit beyond which they will

not use cycloplegia. Yet there is no age limit beyond which the employment of cycloplegia may not occasionally be necessary, after satisfying ourselves that the eye is not glaucomatous. Set rules as to the amount of presbyopic correction are misleading, and were in some degree based upon the fact that most cases of hyperopia were undercorrected, so that the patient's supposed presbyopia was partly an uncorrected hyperopia.

The ophthalmologist whose diligent self-training has developed the analytical habit, based upon a mental picture of the eye and its optical physiology, is likely to face successfully each new refractive problem as it arises. W. H. Crisp.

BOOK NOTICES

PSYCHOTHERAPY IN MEDICAL PRACTICE. By Maurice Levine. Clothbound, 320 pages. New York, The Macmillan Company, 1942. Price $3.50.

The interest of the lay public in psychiatry, psychoanalysis, mental hygiene, and child guidance during the past 20 years has grown faster that the spread of adequate information within the general medical profession. The present volume has been written for the general practitioner and medical specialists, and for medical students.

Psychotherapy means treatment by psychologic measures; that is, through the functions that are associated with speech, perceptions, thinking, emotions, and the relationships with other people and with objects. "It means treatment applied directly to the mind." The purpose of psychotherapy may be alleviation or cure of symptoms, an increase in life happiness, an increase in efficiency, or an increased feeling of security, self-confidence, or of self-respect. The methods of psychotherapy available for the general practitioner include physical examinations, physical treatment, occupational therapy, establishment of a daily routine, the development of hobbies, reassurance, suggestion, suggestion therapy, guidance, and advice, "rest cures," and so on. These methods are all used more or less routinely in the daily practice of all branches of medicine by the general physician. The use of shock therapy, hypnosis, and psychoanalysis belongs to the advanced specialist in psychotherapy.

The mistakes in psychotherapy made by the general practitioner are often caused by: (1) A failure to realize the position of influence and authority awarded to the physician by the patient; (2) the impression that psychotherapy is a complicated mysterious subject; (3) the use of only one or two forms of minor psychotherapy; (4) the physician's often treating symptoms instead of treating the person; and (5) the fact that physicians are often too grim and serious in dealing with patients. A sense of humor may be very helpful.

Dr. Levine repeatedly stresses the attitude of the physician toward the patient as being most important. The attitude advised is one "that is non-condemming and non-critical, non-judgmental and accepting. The opposite attitude of criticism, blame, sitting in judgment, putting to shame, etc., is fundamentally destructive and futile."

The chapters on sex and marriage, basic attitudes toward children, and the problems of parents and children are best read in full.

This book is very readable, fulfills the author's purpose, and casts light on a much-maligned phase of medical practice.

William M. James.

INDUSTRIAL PSYCHOLOGY. By Joseph Tiffin, Ph.D. Clothbound, 386 pages, illustrated. New York, Prentice-Hall, Inc., 1942.

This book deals with applications of psychology that have been made in industry. These applications consist of a number of procedures and techniques that are covered in detail in the various chapters. Much of the contents of the book is the original research of the author, who is a professor of industrial psychology at Purdue University.

Chapter one is concerned with the significance of individual differences in industry, discussing the basis and magnitude of the differences, and how they affect job qualifications. The next four chapters deal with employee testing. In order, they are: General principles of employee testing, Mental ability and mechanical comprehension tests, Dexterity, manipulative, and achievement tests, and Tests of personality and interest.

Of chief interest to the ophthalmologist is chapter six, titled Visual problems in industry, the longest in the book. The theory and technique of the measurement of vision is first discussed, with the Snellen test cards being accepted as the most satisfactory method. The measurement of the visual loss for compensation purposes in terms of visual efficiency is explained. Visual-acuity levels for employment and for job placement are next outlined. The author, realizing the importance of individual differences in vision in relation to allocating employees to specific jobs, advises tests specifically adapted for industrial purposes and conditions. These tests probably can best be given on some type of stereoscopic instrument, the visual acuity, depth perception, color discrimination, and the muscle balance being tested.

The importance of vision in industry can be demonstrated only in relation to acceptable industrial criteria such as hourly production, defective workmanship, or supervisors' ratings. In most jobs, especially those involving inspection or clerical work, visual factors are quite important in determining employee efficiency. However, in certain jobs of fine assembly work, employees with poorer vision actually had a higher output than those with normal vision, but the quality of work was definitely lower. This is probably due to a more critical concept of the standard of work and to more frequent correction of mistakes with resultant slowing. The specific visual requirements of different jobs can be determined only by careful studies of the relationship existing between vision-test results and the employees' efficiency.

An important part of an industrial program of vision is the recognition and simplification of visual operations in the plant and the improvement of visual working conditions. The visual operations of any job should be organized into a restricted area at a convenient and fairly uniform distance from the eyes. The use of occupational eye wear, such as optical filters and hardened protective lenses, is well recognized, but the author shows that the visual efficiency of the employee is definitely increased by the use of a properly fitted spectacle. Proper job lighting should give attention not only to general illumination but also to specific job requirements for illumination.

In the visual maintenance of personnel there should be periodic retests of vision, maintenance of proper eye wear, and adequate protection from industrial hazards such as trauma or occupational diseases.

An adequate industrial visual program must include a plan and system for gathering factual data, classifying and evaluating it, and making it available for the interested departments. This program also should include a plan for employee education in vision.

The remaining six chapters of the book are discussions of the following subjects: Training of industrial employees, Work, fatigue, and efficiency, Industrial merit

rating, Industrial inspection, Accidents and safety, Attitudes and morale.

The use of applied psychology as a tool of industrial management will undoubtedly continue to expand. Along with this, there will be a corresponding increase in the study of the theories, facts, and needs of vision in industry. A proper understanding of these visual problems of industry is not only essential for the industrial ophthalmologists, but it also could be of much use in the proper management of many of the occupational difficulties of the individual patient in private practice. T. E. Sanders.

CORRESPONDENCE

August 1, 1942

To the Executive Committee of the Section of Ophthalmology of the American Medical Association:

There is a great need, it seems to us, for amplification of present machinery to facilitate the handling of the problems that have to do with the distribution of ophthalmologic care and our public relations as related thereto.

Among recent problems of ophthalmology are our relations to opticians and optometrists, the problems of ophthalmologists' making a retail profit on glasses, and consideration of the training of ophthalmologic technicians.

Our public relations have been somewhat strained. We have been put in a bad light before the public and the press (see PM, Monday, April 6, 1942). It appears to the press, to labor, to governmental interests in Washington, etc., that skullduggery is rampant in the medical profession. Our poor public relations in this regard, as far as ophthalmology is concerned, may have done damage that is irreparable, particularly in this changing order. Unfortunate misunderstandings have developed within the medical profession over these subjects, largely because of a lack of time to discuss important matters before they get to the public.

The executive committee of the Section does the best it can with the time at its disposal. We believe, however, that they arrive at too many conclusions unaided by the counsel of a sufficient number of men, and that they should have the benefit of collaboration with ophthalmologists over the country.

Last year a pronouncement was made on the subject of retail profits on glasses which did much damage, although we believe the one who made the statement thought he was doing a good thing. Instead of being praised for his effort, he is roundly condemned by 90-odd percent of ophthalmologists, many of whom conform wholly to what he lays down as perfectly ethical. Fully 90 percent of ophthalmologists think a very great mistake was made in giving the statement first-page publicity. We believe the Journal of the A. M. A. would not have proceeded as it did if it had had all the facts. Even the Section on Ophthalmology is only partially informed as to all the facts because there has been through the years a lack of machinery and a failure to set aside adequate time for the Section to learn the truth from the various states on these important economic and medical distributionary problems of ophthalmology.

Millions of people have had good eye care made possible because the doctor of medicine has made some retail profit on glasses, and so could manage with fees of nothing, three, five, or ten dollars as the case might be, for his services, and the people have had care. Millions have had care in hospitals and free clinics because some one has given money to hospitals and clinics which was made from retail profits on some manufactured products. Money made from retail profits has contributed to medical care all the way

from small clinics up to the great foundations. Doctors spend thousands of hours in free clinics with no compensation, and they care for many in their offices without charge. The philanthropist is lauded and memorialized for the money he gives to a free clinic, and properly, where the doctor, without whom the philanthropist's gift could not function, gives his valuable time. But the doctor is a very bad actor, according to this recent pronouncement, when he uses a retail profit to help finance his personal public service.

Some of these things just have not been thought through. In some parts of the country ophthalmologists receive no profit on glasses and charge $25.00 or more for refractions. Besides paying high fees in such areas, the patients pay the full price for glasses to some one else. In areas where this prevails the majority are driven to free clinics, jewelry stores, department stores, and dollar stores for care, partially because of such a system making costs to the patients too high. All the considerations have not been thrashed out around a table by adequate representatives from all the states and conclusions arrived at adequately before pronouncements are made. Enough thought and attention has not been given to the economic, distributive, interprofessional, and public-relations aspect of this particular subject.

The desire of certain doctors to use optometrists and technicians in the clinics they serve is perfectly logical if done on the doctors' or clinics' responsibility. They see the need of increasing their own effectiveness by using trained technical assistants, and by so doing give medical care to more people, just as engineers in the automobile industry decrease the cost of cars to the people by supplementing their skill with that of toolmakers and other technicians under their care. The quality of the cars would not be very good without the constant supervision of the engineers, however. We have men in this vicinity who employ technicians as well as medical assistants. The method serves a good purpose. More people are cared for, and they are given better care. An investigation of the system should be made. Such doctors should be allowed to continue their experiments without being judged unethical, and with the sanction, approval, and encouragement of the Section on Ophthalmology. They would probably ultimately be glad to bring in a report of the economic and scientific value of the arrangement in its relationship to the distribution of medical care. The Section should be able to authorize them to do that officially and still not recognize ethically all optometrists. We do not have to enter into collaboration with every optometrist with a blinking eye in the window in order to try out such arrangements, any more than the American Academy of Ophthalmology and Otolaryngology needs to take into membership every doctor of medicine who happens to have a trial case.

It would seem to us not to be a good thing for that group of optometrists who are trying to do good work and to raise their standards, if the medical profession gave recognition to all optometrists on the same basis.

Chiefs of ophthalmologic departments should be encouraged to set up, in connection with medical schools, experiments in the training of ophthalmologic technicians, with the sanction, encouragement, and coöperation of the Section on Ophthalmology of the A. M. A., just as certain universities train laboratory technicians to assist the medical profession.

Representatives from various states should be called in to lay on the table the facts of the cost of ophthalmologic care, facts of what the doctors charge for services, and what they make from glasses, and see whether the retail profit to doctors makes costs higher to the pa-

tients, or whether, after all, there may not be a decided advantage to the people by this system. We believe that we can show that hundreds of thousands of dollars have been saved and are being saved the public by this method, but no such impression has gone out to the public.

Possibly the answer to the retail-profit problem lies in selling glasses to the public wholesale. If so, all right, but would the fair-trade laws allow such a thing? Would it be fair to optometrists? Is a retail profit in manufactured goods essential to the American way of life, or isn't it?

As it now stands, a subject has to come up before the Section of the A. M. A., be deliberated upon briefly and acted upon; possibly acted upon wrongly. Another whole year has to pass before it can be readjusted, if at all, and then only because some one has had to force the action in an exceedingly short business session; short in comparison to the importance of the subject. The Section leaders intend to do the right thing, but they cannot arrive at adequate conclusions either for themselves or the cause without spending more time with more men from various sections of the country.

The A. M. A. Section devotes relatively little time to these subjects in meetings; the American Academy of Ophthalmology and Otolaryngology refuses to consider them at all. Ethical standards are set up by medicine to protect the public, and vast scientific developments are worked out in the interest of the public at very great cost, but all can be greatly damaged by our failure to spend enough time among ourselves to be adequately informed, and to give out information by which the government and the public can be adequately informed. We lead well scientifically, but are we leading well otherwise?

There should be round-table discussions by representatives from all the states on the subject of the distribution of ophthalmologic care, and on the subject of opticians and optometry in this regard, since it is a current subject and one which is being stimulated through the National Society for the Prevention of Blindness. Another consideration should be on the possibilities of the training of technicians in ophthalmology. A fourth would be to ascertain just whether the retail profit on glasses is, or is not, to the benefit of the public.

In our judgment these things can never be worked out in the short business sessions held during Section meetings of the A. M. A., nor can the Executive Committee, or any committee alone, be expected to pass judgment and bring in reports that can be justly conclusive.

The medical profession is too important in national affairs at all times to have our public and private relations disturbed by the failure of any section to bring to the parent organization other than the most adequately worked out proposals possible relating to the distribution of medical care that is so splendidly worked out scientifically.

After such deliberation and the conclusions presented to the Section in the annual meeting, a report can go to the House of Delegates which that body can act on comprehensively, then the A. M. A. will be able to give out publicity that should reflect greater credit on the medical profession.

We shall be glad for your early suggestions as to the next step.*

(Signed) Ralph H. Pino, M.D.
Chairman of the Committee on Distribution of Medical Care of the Detroit Ophthalmological Society

* In response to this letter the Journal editor invited a communication on this subject for publication in the Journal, and the writer suggested that the letter itself be published.

ABSTRACT DEPARTMENT

EDITED BY DR. WILLIAM H. CRISP

Abstracts are classified under the divisions listed below, which broady correspond to those formerly used in the Ophthalmic Year Book. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. General methods of diagnosis
2. Therapeutics and operations
3. Physiologic optics, refraction, and color vision
4. Ocular movements
5. Conjunctiva
6. Cornea and sclera
7. Uveal tract, sympathetic disease, and aqueous humor
8. Glaucoma and ocular tension
9. Crystalline lens
10. Retina and vitreous
11. Optic nerve and toxic amblyopias
12. Visual tracts and centers
13. Eyeball and orbit
14. Eyelids and lacrimal apparatus
15. Tumors
16. Injuries
17. Systemic diseases and parasites
18. Hygiene, sociology, education, and history
19. Anatomy, embryology, and comparative ophthalmology

1

GENERAL METHODS OF DIAGNOSIS

Bedell, A. J. **Ophthalmoscopic findings versus sinusitis.** New York State Jour. Med., 1942, Jan. 15, p. 128.

Bedell cites numerous common serious ophthalmic conditions erroneously diagnosed by nonoculists as sinusitis.

Theodore M. Shapira.

Bourbon, O. P. **An improved pupillometer.** Amer. Jour. Ophth., 1942, v. 25, Sept., pp. 1107-1108.

2

THERAPEUTICS AND OPERATIONS

Alexeeva, V. I. **Tuberculin therapy.** Publications Helmholtz Inst. of Ophth. (Russia), 1940, p. 168.

Tuberculin was included among the therapeutic agents in 1923. From 1923 to 1935 the treatment was administered to 336 patients. The disease was bilateral in 30 percent of the cases: the number of bilateral cases appears to increase with the age of the patients. The prognostic significance of the duration of the disease may be gleaned from the following figures. In 60 percent of patients discharged improved or cured the duration of the disease on admission was under six months, and in 40 percent over six months. In the unimproved group the duration of the disease on admission was under six months in 44 percent, and over six months in 56 percent. The data on the final visual results classify 3 percent as completely cured; 66.3 percent as improved, this group comprising the patients with regression of inflammatory symptoms, and those in whom the inflammatory process had run its course, leaving behind corneal opacities, precipitates, synechiae, vitreous opacities, and other manifestations; 22.6 percent in whom the therapy was ineffective; and 7.8 percent who became worse. The results were less satisfactory in children than in adults. Ray K. Daily.

Avalos, Enrique, **Dagenan in ophthalmology.** Anales de la Soc. Mexicana de Oft. y Oto-Rino-Lar., 1942, v. 17, Jan.-Feb., p. 27.

Dagenan is a mixture of sulfanilamide and pyridine, as described by

Flemming. The author reports four cases of severe corneal ulceration caused by the pneumococcus, and one of metastatic conjunctivitis caused by the gonococcus. The dose was three grams daily; the response was prompt and healing rapid. The usual local treatments were applied.

Eugene M. Blake.

Boyd, J. L. **Sodium sulfathiazole iontophoresis.** Arch. of Ophth., 1942, v. 28, Aug., pp. 205-213.

Sulfathiazole has a greater bacteriostatic action than some other sulfonamides but unfortunately does not easily penetrate the eye. An attempt was made to increase concentration in the rabbit eye by employing anion electrolysis. A 5-percent aqueous solution of sodium sulfathiazole was used in both the electrolized eyes and the controls. A galvanic current of 40 volts and from 1 to 5 milliamperes was used. After exposure to the sulfathiazole the eyes were enucleated and quantitative determinations made of the concentration in the cornea, aqueous, and vitreous. It was found that with a current of 1 milliampere acting for two minutes the sulfathiazole concentration of the cornea and aqueous could be increased three times. With a current of 2 milliamperes the concentration in the cornea and in the aqueous was ten and nine times, respectively. No ocular damage was observed with the use of a current that produced a sulfathiazole concentration consistent with optimal bacteriostatic effect. Sulfathiazole concentrations in the vitreous were small and erratic. (5 charts, bibliography.)

John C. Long.

Bronstein, F. G., Ratner, I. I., Barkman, S. M., and Baliukaja, E. H. **Postoperative infection.** Publications Helmholtz Inst. of Ophth. (Russia), 1940, p. 172.

From 1900 to 1935, inclusive, 13,912 intraocular operations were performed; 8,695 being cataract extractions, of which 7,094 were senile, 620 traumatic, and the rest congenital. There were 214 infections in the cataract cases; and 709 cases which had vitreous loss included six cases which developed panophthalmitis and 38 with wound infection. Of these 44 eyes 15 were lost. Thus 2.1 percent of those in which vitreous escaped were lost. Of the 6,285 uncomplicated senile extractions 154 developed infection: 21 had panophthalmitis and 133 had wound infections; and 82 eyes or 1.3 percent were lost. The author believes these data indicate that loss of vitreous predisposes to infection. In 4,368 iridectomies, 17 postoperative infections (0.06 percent) occurred. Three were cases of panophthalmitis, and 14 of wound infection. Two cases of panophthalmitis and five wound infections occurred among 849 discissions.

The complications of 1,894 rhinostomies were erysipelas in 17 cases, and infection of the sutures in 97. In 1,868 extirpations of the lacrimal sac there were 20 cases of erysipelas, and 262 wound infections.

Among 619 strabismus operations one case developed necrosis of the sclera, with recovery. In 485 neurectomies one case developed necrosis of the bulbar conjunctiva, and the eyeball was exenterated. Of ten cases of corneal transplantation one became infected. Infection developed in three cases after operation for staphyloma, Of 121 cases of sinusitis three developed erysipelas.

Ray K. Daily.

Promtov, V. A. **Local and general anesthesia as used at the Institute dur-**

ing its 35 years. Publications Helmholtz Inst. of Ophth. (Russia), 1940, p. 140.

The author traces the evolution and the ever-expanding application of modern local anesthesia with consequent restriction in the use of general anesthesia. The anesthetic injections used for the various surgical ophthalmological procedures are described in detail and well illustrated. Of the general anesthetics only chloroform and ether are used. (Illustrations.)

Ray K. Daily.

Sanyal, S., and Maitra, M. N. **Ocular conditions common in India and their local treatment with sulfanilamide.** Arch. of Ophth., 1942, v. 28, July, pp. 27-56.

Sulfanilamide ointment was used in over five hundred cases of keratoconjunctivitis with adenitis as found in India. It was found to be beneficial, not only in cases of acute keratitis, but also in those with pannus, interstitial keratitis of both the vascular and avascular type, and dacryocystitis. It was also found to be beneficial in cases of postoperative sepsis and in certain noninflammatory conditions such as xerosis and leukoma. Because of the effect of the drug in the noninfective as well as in the infective conditions, the study was undertaken for determination of its effect upon the normal conjunctiva and cornea and on incised wounds of the cornea. In the conjunctiva it induced proliferation of the epithelium, infiltration of the subepithelial cells, dilatation of the blood vessels, and edema. In the cornea there were hyperplasia of the epithelium, change in the shape and the size of the corneal corpuscles, and cellular infiltration at the periphery. Thus, even if sulfanilamide had no bacteriostatic property it would ably defend the tissues in its role as a chemical excitant. This explains the drug's effect in such conditions as xerosis and leukoma. Experiments now being conducted seem to indicate that addition of intravenous administration is beneficial in conditions of the conjunctiva, but is of doubtful value in corneal lesions.

J. Hewitt Judd.

Swan, K. C., and White, N. G. **Corneal permeability. 1. Factors affecting penetration of drugs into the cornea.** Amer. Jour. Ophth., 1942, v. 25, Sept., pp. 1043-1057. (10 tables, 6 figures, bibliography.)

Vasquez Barrière, A. **Three-blade retractor for retinal detachment and orbital surgery.** Arch. de Oft. de Buenos Aires, 1941, v. 16, Sept., p. 533.

The author describes a new retractor for better exposure of the operative field in retinal detachment and orbital surgery. The instrument is a modification of Laborde's tracheotomy forceps, with three blades shaped to the convexity of the sclera. (Illustrations.)

Plinio Montalván.

3

PHYSIOLOGIC OPTICS, REFRACTION, AND COLOR VISION

Bridgman, C. S., and Smith, K. U. **The absolute threshold of vision in cat and man with observations on its relation to the optic cortex.** Amer. Jour. Physiology, 1942, v. 136, May 1, p. 463.

After training cats to respond to minimal amounts of light at absolute thresholds, the visual areas of the cerebral cortex were removed. When the animals were retested, the authors found that the optic cortex played a significant role in certain aspects of

brightness discrimination, it apparently being directly involved in defining the limits of vision at absolute threshold. T. E. Sanders.

Cherif, M. de R. **A case of insomnia of ocular origin.** Anales de la Soc. Mexicana de Oft. y Oto-Rino-Lar., 1942, v. 17, Jan.-Feb., p. 1.

A man aged 34 years had suffered for eight years from insomnia. At first the symptoms appeared after reading at night. Later they would occur if reading was done during the daytime. Thorough physical, neurologic and psychiatric examinations were made, without finding a cause or affording relief. Several ophthalmologists examined the eyes and found them normal. The author ordered a +0.25 cyl. ax. 125° for the right eye, and +0.25 cyl. ax. 75° for the left eye, with rapid and complete relief of the insomnia. He suggests as a possible explanation of the relief the abolition of spasm of the ciliary and other muscles.

Eugene M. Blake.

Fischer, F. P., and Wagenaar, J. W. **On the method of examination of binocular vision.** Ophthalmologica, 1942, v. 103, March, p. 129.

The stimulus that started the work reported in this essay was the observation that a trained physiologist when tested with Hering's test seemed to have no binocular single vision, yet when tested with the horopter apparatus made normal adjustments with the utmost delicacy. The tests are analyzed in detail, and it is shown that the essential difference is that one depends on simultaneous observation of units of the test objects and the other on successive observation.

On the basis of their analysis, the authors conclude that a complete examination of binocular vision need not be difficult nor time-consuming but must consist of the following tests: (1) examination of heterophoria with (a) Maddox scale and Maddox cylinder for distance, and (b) Bielschowsky's or similar miniature Maddox scale for near; (2) test for exclusion with red and green Snellen letters or ordinary stereoscope with the figures of illustration W on plate 6 of Helmholtz, v. 3, third edition; (3) examination of binocular vision with Hering's drop test, the horopter test, and occasionally Pulfrich's pendulum test.

The authors did not have access to Verhoeff's description of the kinetic test for stereoscopic vision until after completion of their manuscript.

F. Herbert Haessler.

Fox, S. A. **Traumatic myopia with hypotony.** Arch. of Ophth., 1942, v. 28, Aug., pp. 218-234.

The author gives an extensive review of the literature on traumatic myopia and hypotony with a discussion of various theories of causation. Myopia and hypotony frequently occur together as the result of concussion or indirect trauma. The condition usually disappears in two or three weeks but may last for several years and may be permanent. Ciliary spasm is responsible for transient cases of myopia, while zonular relaxation or injury may account for the more prolonged ones. Interruption of the formation of aqueous with anterior displacement of the lens may also be an important factor, especially in the production of hypotony. Both traumatic myopia and hypotony may exist for several years without permanent impairment of vision. No treatment is of avail. Two

cases of traumatic myopia, hypotony, and choroidal rupture are reported. In one there was complete recovery after 28 months. The other showed a partial recovery after 12 months but was not seen again. (64 references.)

John C. Long.

Goldmann, H. **Stiles-Crawford effect.** Ophthalmologica, 1942, v. 103, April, p. 225.

In 1933 Stiles and Crawford discovered that a source of light appeared brighter when the rays which formed the image entered the eye through a central area of the pupil than when they passed through its periphery. Two explanations are possible: (1) that the rays that traverse peripheral parts of the media lose some of their intensity; (2) that retinal receptors are most sensitive to rays which traverse them longitudinally. Heretofore, only indirect evidence has been available. By means of slight modifications of the large Gullstrand ophthalmoscope, it was possible to demonstrate unequivocally that the Stiles-Crawford effect arose in the retina. The intensity of the sensation of brightness depends on the azimuth of the rays which impinge on the retina. The immediate cause of the phenomenon is unknown. Pigment migration, which might explain the phenomenon, has not been demonstrated in the light-adapted human eye. However, it is known that the pigment-free eyes of planarians are insensitive to lateral rays. The phenomenon is doubtless of great practical importance since it reduces the effect of scattered light in the light-adapted eye.

F. Herbert Haessler.

Hunt, W. T., and Betts, E. A. **Visual problems: certain assumptions and data.** Amer. Jour. Ophth., 1942, v. 25, Sept., pp. 1084-1094. (1 chart, 10 tables.)

McKinney, S. W. **Contact lenses—the invisible eyeglasses.** Jour. Tennessee State Med. Assoc., 1942, v. 35, Feb., p. 58.

The subject of contact lenses is discussed from the standpoint of historical background, indications and uses, and the technique of fitting the molded plastic lens. The author states that these lenses are satisfactory in the majority of cases, although a few patients can never acquire tolerance for them. He hopes that in the future the technique of fitting and manufacture will be so simplified that their usefulness will be much increased.

T. E. Sanders.

Neblett, H. C. **Predominating symptoms in ophthalmic practice.** Southern Med. and Surg., 1942, v. 104, July, p. 401.

Analysis of the histories of the author's patients over a period of 22 years in ophthalmic practice shows headache as leading the list of symptoms complained of.

By the majority of patients, it is assumed that headache anywhere in the skull and even in the neck comes from the eyes and that glasses will solve the problem. This calls for careful analysis of location, type, degree, and incidence of the headache in order that the oculist may determine whether it is organic or functional in nature. Study of habits, diet, type and hours of work, lighting, emotional trends, and general physical condition must be made. If none of these factors throw light on the cause then habit headache should be considered.

Difficulty sometimes arises in patients with a fixed idea that glasses are needed to relieve headache which they have been told was caused by eyestrain. The author feels that those who obtained glasses of ⅛ or ¼ diopter sphere elsewhere, and were improved by the correction after he himself had refused to prescribe correcting lenses, were psychic cures or cases where some extraocular cause for the headache corrected itself or was corrected by some other means coincidental with the use of the glasses. This opinion is based on the fact that many patients with high simple refractive errors seldom complain of headache as their main symptom but rather fatigue, smarting of the lids, and blurred vision. Careful analysis and notation of results will prove that 60 to 70 percent of functional headaches are not due to eyestrain resulting from refractive errors, although this has been taught for many years.

F. M. Crage.

Sullman, H., and Schmid, A. E. **On oxydoreduction systems of the retina. Ascorbic acid and glutathione.** Ophthalmologica, 1942, v. 103, March, p. 150.

Quantitative studies of the ascorbin content of the retina of calves and rabbits are reported. Experimentally, the authors found no difference between the ascorbin content of the retina of light-adapted eyes and dark-adapted eyes of calves and rabbits. Exposure to light does not change the ascorbin content of enucleated eyes. The writers conclude that ascorbin is highly stable to light. The experiments do not justify any conclusions as to the importance of ascorbic acid in the retinal adaptive process. Protein-free extracts of the retina give a positive nitroprusside reaction, showing that the retina contains SH groups. F. Herbert Haessler.

4

OCULAR MOVEMENTS

Argañaraz, Raul. **Functional strabismus.** Arch. de Oft. de Buenos Aires, 1941, v. 16, Aug., p. 409.

The author discusses at length the anatomic and physiopathologic phases of functional strabismus. The orthoptic treatment comprises careful correction of the refractive error determined under atropine cycloplegia, measures to improve the visual acuity of the amblyopic eye, and visual re-education, for which the author finds the Maddox cheiroscope to be the best instrument. The deviation tends to decrease throughout later childhood and adolescence, but usually remains unchanged after the age of twenty years, when surgical correction can be best undertaken as a cosmetic cure.

The different surgical procedures yield uniform results when properly indicated and skillfully performed. The author discusses the various types of operation such as simple tenotomy, double tenotomy, and tenotomy combined with advancement. He reports a series of cases to illustrate the results obtained. (Photographs.)

Plinio Montalván.

Dunnington, J. H., and Wheeler, M. C. **Operative results in two hundred and eleven cases of convergent strabismus.** Arch. of Ophth., 1942, v. 28, July, pp. 1-11; also Trans. Amer.. Acad. Ophth. and Otolaryng., 1942, 46th mtg., March-April, p. 206.

This analysis is based on 211 cases of convergent strabismus in a group of 349 cases in which operation was performed for a muscular anomaly. The

average age at onset of convergent strabismus was found to be 1.9 years. Neither the age at onset nor the refractive error bore any relationship to the severity of the squint. Vision of 20/100 or less was present in one of four cases in which there had been no treatment. In 68 percent of the cases of convergent squint the refractive error was less than 3 D. of hyperopia, and severe anisometropia was found in only seven cases. The average amount of deviation in all age groups was 47 prism diopters. Simultaneous resection and recession on the same eye produced on the average 40 prism diopters of correction. The results with this combined operation were definitely inferior in those cases in which there was alternate fixation. In 43 percent of 163 cases one operation was sufficient to reduce the deviation to 10 prism diopters or less, while an undercorrection was obtained in 44 percent and an overcorrection in 13 percent. Of those cases in which a secondary operation was performed a satisfactory result was obtained in 72.2 percent. The age at the time of operation seemed to have no bearing on the result except that there was an increased tendency toward production of overcorrection in patients operated upon between the ages of three and eight years. The rare postoperative complications consisted of eight subconjunctival cysts and three granulomas of the conjunctiva. In three cases there was persistent postoperative diplopia, but it was distressing in only one. (Discussion.) J. Hewitt Judd.

Gavey, C. J. **Ophthalmoplegia as sole manifestation of myasthenia gravis over 25 years.** Proc. Royal Soc. Med., 1941, v. 35, Nov., pp. 14-15.

The left upper eyelid had begun to droop and diplopia had appeared 25 years previously. The condition was stationary for several years. Eighteen months before the date of report the right eye became similarly affected. There had been no dysphagia, weakness of the limbs, or difficulty in mastication or speech articulation.

W. H. Crisp.

Guy, L. P. **Ocular torticollis—differential diagnosis.** Arch. of Ophth., 1942, v. 28, July, pp. 17-26.

The author discusses the diagnosis of ocular torticollis as differentiated from the orthopedic and neurologic types. In ocular torticollis the history of forceps delivery is frequent. The torticollis has been present since the development of fusion from the age of two years or since an accident, the deformity can be voluntarily corrected by the patient, examination of the ocular muscles shows the vertical error or ptosis of an upper lid, there is no facial asymmetry, and roentgenograms of the cervical portion of the spine are normal. (Discussion.) J. Hewitt Judd.

Verhage, J. W. C. **A clinical study of latent nystagmus.** Ophthalmologica, 1942, v. 103, April, p. 209.

Most authors who have written on latent nystagmus have based their generalization and theoretic consideration on very small series. Therefore, the author collected thirty cases of this uncommon though not really rare condition.

Latent nystagmus is characterized by a constant association of certain symptoms, so that it may be considered a clinical entity, and not a mere collection of the heterogeneous varieties of nystagmus that occur when one eye is closed. Typical patients with latent nystagmus are free from oscillation when both eyes are open, but when one eye

is closed an associated jerking nystagmus toward the side of the open eye occurs.

The most important result of this comparative study was the discovery of a clinical association with alternating hyperphoria and certain associated ocular rotations with closure of one eye. The author classifies all these manifestations as a "contrast syndrome." The precipitating factor is a disturbance in the equilibrium between right-sided and left-sided stimuli in the supranuclear centers. The slow phase of the latent nystagmus represents the horizontal component of the syndrome, the alternating hyperphoria represents the vertical component, and the rotations the frontal. Ohm's observation that in some patients this nystagmus becomes manifest in absolute darkness was confirmed.

Latent nystagmus is less rare in children, more so in adults, and almost unknown in the presbyopic age. It seems to wane in intensity in the course of life and finally to disappear.

F. Herbert Haessler.

5

CONJUNCTIVA

Barnshaw, H. D. **Inclusion blennorrhea.** Jour. Med. Soc. New Jersey, 1941, v. 38, June, p. 312.

The author reports four cases of inclusion blennorrhea diagnosed by scrapings containing inclusion bodies.

Theodore M. Shapira.

Castillo, J. L. **Contribution to the treatment of gonococcic conjunctivitis with sulfonamides.** Arch. de Oft. de Buenos Aires, 1941, v. 16, Aug., p. 444.

The author reports four cases of gonococcic conjunctivitis treated successfully with sulfonamides. The course of the disease was considerably shortened, and, particularly in adults, this method of treatment proved superior to any previously used.

Plinio Montalván.

Eber, C. T. **Vernal conjunctivitis.** Jour. Missouri State Med. Assoc., 1942, v. 39, June, p. 171.

The author reviews at some length the literature on all aspects of vernal conjunctivitis. He concludes that its etiology is still unknown, but that the data point to hypersensitivity of susceptible conjunctivas to certain antigens. The treatment is still symptomatic, although, from the atopic nature of the disease, possible desensitization or general therapeutic care is at times indicated.

T. E. Sanders.

Gubina, H. M., Repnikov, I. A., Savaitov, A. C., and Shlikova, B. D. **Trachoma.** Publications Helmholtz Inst. of Ophth. (Russia), 1940, p. 132.

The trachoma division of the Institute comprises 25 beds for adults, and 50 for children. The material for the 35-year period consisted of 2,791 patients, representing 4.9 percent of all cases. There were 1,485 men and 1,306 women. Levkoeva, the pathologist of the Institute, attaches no diagnostic significance to the Prowazek inclusion bodies. Trachoma, distinct from follicular conjunctivitis, is regarded as a chronic infectious inflammatory process, characterized by conjunctival infiltration and development of follicles in the conjunctiva, semilunar folds, and tarsus, and a tendency to cicatrization and involvement of the cornea, lids, and lacrimal apparatus. Cytologic studies are made for differential diagnosis of the late stages and for study of the dynamics of the process. There were no

radical therapeutic changes during the 35 years. Of the new therapeutic agents, chaulmoogra oil and peryl oil combined with massage hasten cicatrization and shorten the second stage during which corneal complications are most frequent. Cod-liver oil and a nourishing diet are a part of the therapeutic routine for stimulating the defensive forces of the organism. Corneal complications are treated with autohemotherapy. Ray K. Daily.

Halloran, Chris. **Pemphigus of the eye.** Arch. Dermatology and Syphilology, 1942, v. 46, Aug., p. 246.

The author reminds us that ocular pemphigus may be seen in acute pemphigus or in pemphigus vulgaris. In the conjunctiva the essential process is invasion of the submucous tissue by newly formed connective tissue, which later contracts. Three cases of pemphigus with ocular involvement are reported. Whalman, in discussing the paper, said that he had seen four cases, although statistically the condition had been reported as occurring only once in 46,000 cases of ocular disease. He also mentioned that conjunctival lesions frequently precede the development of cutaneous lesions by months or years.

Ralph W. Danielson.

Hogan, M. J., and Crawford, J. W. **Epidemic keratoconjunctivitis.** Amer. Jour. Ophth., 1942, v. 25, Sept., pp. 1059-1078. (9 figures, 1 table, extensive bibliography.)

Koke, M. P. **Acute follicular conjunctivitis resembling Béal's type.** Amer. Jour. Ophth., 1942, v. 25, Sept., pp. 1100-1101. (References.)

Malbrán, J., and Tosi, B. **Epithelial plaque of the conjunctiva.** Arch. de Oft. de Buenos Aires, 1941, v. 16, Sept., p. 484.

The authors report a conjunctival plaque in a patient 23 years of age. The lesion, situated in the zone corresponding to the pinguecula of the right eye, was a small whitish area, about the size of a grain of rice, and staining with fluorescein. It showed slight elevation, and moderate engorgement of the neighboring conjunctival vessels. Histopathologic examination showed proliferation of the epithelium resembling the structure of postnevus epithelioma.

The authors discuss the literature concerning cornification and keratosis of the conjunctiva and stress the similarity of their cases to those reported by Stock, who points out the rarity of the condition and the possibility of external etiologic factors in view of the location of the lesion in the exposed bulbar conjunctiva. (Illustrations, photomicrographs, bibliography.)

Plinio Montalván.

Poole, W. A. **Surgical treatment of trachoma.** Kentucky Med. Jour., 1942, v. 40, Feb., p. 49.

The author feels that the rule of avoiding surgical treatment in the acute stage of trachoma is just as unreasonable as postponing needed surgery in acute appendicitis. Acute cases are cured in a few weeks by surgery as compared with many months of treatment by nonsurgical measures. The various surgical procedures are considered and two abnormalities of the skin and conjunctiva of the trachomatous patient are emphasized. (1) A trachomatous conjunctiva cannot be stretched. (2) The skin of a trachomatous patient is usually thick and waxy, and scars and sloughs easily.

Edna M. Reynolds.

Re, B. V., and Blanco, M. G. **Primary mycotic conjunctivitis.** Arch. de Oft. de Buenos Aires, 1941, v. 16, Sept., p. 513.

A case of unilateral fungus conjunctivitis is reported. The lids showed moderate inflammatory edema. In addition to a profuse conjunctival discharge of thick yellowish material, there was an exudative mass adherent to the lower cul-de-sac. The rest of the conjunctiva was edematous but the cornea and the lacrimal passages were uninvolved. Laboratory examination of the exudate showed blastomycetes, genus Candida, subfamily Mycotoruleae.

The authors inoculated rabbit eyes with pathologic material from the patient and were able to reproduce experimentally a mycotic conjunctivitis. No keratitis could be produced by intracorneal injection, but a plastic iridocyclitis was obtained by inoculation into the anterior chamber. Intravenous inoculation of the material produced, particularly in the kidneys, liver, and lungs, disseminated nodular lesions from which the fungus was recovered. After local and systemic treatment with sodium and potassium iodide had failed, sulfanilamide, in doses of three grams per day, produced a complete cure in a period of one week.

The literature concerning mycotic conjunctivitis is briefly discussed. The authors believe that this is the first case of blastomycotic conjunctivitis reported in the medical literature.

Plinio Montalván.

Victoria, V. A. **Attenuated trachoma.** Arch. de Oft. de Buenos Aires, 1941, v. 16, Aug., p. 440.

The author discusses a type of attenuated trachoma of very low-grade intensity, characterized by normal or slightly hyperemic conjunctiva with very little, if any, trachomatous granulation or scar tissue present. The slitlamp reveals an increase of limbal vascularization with a few loops invading the cornea for a distance not greater than 1.5 to 2 mm. These vessels are very superficial and are frequently accompanied by very tiny infiltrates. Herbert's marginal pits and corneal nodules are usually absent. In the majority of these patients it is possible to find an epidemiologic antecedent which is of definite diagnostic importance.

The clinical picture differs from that described by Busacca and Toulant. The disease is an attenuated form of trachomatous infection found endemically in northern Argentina. It deserves a place in the classification of the clinical types of the disease, and all public antitrachomatous services should be provided with adequate facilities for slitlamp examination as the only means of diagnosing this form of trachoma.

Plinio Montalván.

6

CORNEA AND SCLERA

Andrade, Cesario de. **Interstitial and ulcerous keratitis in leishmaniasis.** Arch. of Ophth., 1942, v. 27, June, pp. 1193-1197.

The ocular lesions of leishmaniasis are described, including their biomicroscopic appearance, and their clinical course and treatment are discussed. The author states that the best treatment is the intravenous injection of antimony and potassium tartrate. Systemic reactions to the drug are sometimes encountered, but are controlled by the use of epinephrine and calcium chloride. Ultraviolet irradiation is useful as an auxiliary treatment, especially in the lesions of the eyelid.

J. Hewitt Judd.

Harkavi, P. A., and Tumarkina, M. A. **Parenchymatous keratitis.** Publications Helmholtz Inst. of Ophth. (Russia), 1940, p. 161.

Of 1,209 cases constituting the material of 35 years, 1,182 (97.7 percent) were attributed to congenital syphilis. Of the other 35 cases 27 were treated with tuberculin. The distribution of the patients over the years shows a rise in the incidence of the disease until 1915, and a gradual and significant decline since. The authors attribute the decline to the more thorough prenatal treatment administered to parents since 1915. While the histories show that antiluetic therapy does not modify significantly the course of parenchymatous keratitis, nor guard against recurrence, the authors believe that antiluetic therapy given to parents has prophylactic value.

Ray K. Daily.

Hogan, M. J., and Crawford, J. W. **Epidemic keratoconjunctivitis.** Amer. Jour. Ophth., 1942, v. 25, Sept., pp. 1059-1078. (9 figures, 1 table, extensive bibliography.)

Joy, H. H. **Treatment of experimental bacillus-pyocyaneus ulcer of cornea with sulfapyridine.** Arch. of Ophth., 1942, v. 27, June, pp. 1135-1164; also Trans. Amer. Ophth. Soc., 1941, v. 39, p. 456.

Local therapy in this condition has probably failed because of the rapid migration of the organisms from the site of infection to other parts of the cornea. Sulfapyridine was chosen for these experiments because it rapidly penetrates the cornea and does not have a deleterious effect upon normal tissue and fluid elements and is bactericidal against certain organisms in concentrations that can be easily attained by therapeutic administration. In-vitro experiments indicate that sulfapyridine sodium in 10-percent concentration is bacteriostatic against three of the four strains of B. pyocyaneus tested.

In animal experiments the oral administration of sulfapyridine sodium proved to be of definite value. Given prophylactically, the drug did not prevent infection of the cornea, but it did materially affect the course of the disease: the ulcer healed, with virtually no progression, in from one to three days if treatment was continued for 24 hours. Relapses, which usually occurred when medication was discontinued at this time, could almost always be avoided if the treatment was maintained over a longer period. A response to treatment was apparent in all animals receiving sulfapyridine sodium six hours after inoculation, and in 87 percent the ulcer healed with little or no extension during the course of the treatment. In 13 percent, in which inflammation persisted for a longer period, the progress of the ulcer appeared to be checked when treatment was discontinued, but the ulcer recurred in 11 percent. The response to therapy was less marked when medication was instituted 18 hours after inoculation, but a favorable effect was apparent in 80 percent of the eyes. In 57 percent healing occurred during the course of the treatment, and 40 percent showing virtually no extension of the ulcer. The course of the inflammation was prolonged and the outcome generally unfavorable in 43 percent of the eyes, 23 percent being definitely influenced by treatment but 20 percent showing little or no response. The concentration of the drug in the blood proved extremely variable both in different rabbits and in the same rabbit on different days. In general no relation could be found

between the concentration and the course and outcome. In the control eyes the course was almost uniformly severe and the outcome unfavorable. Because of the similarity in clinical course of the ulcer in the rabbit eye to that in the human eye, the author suggests that this condition should be treated with sulfapyridine or one of the closely related sulfanilamide compounds.

J. Hewitt Judd.

Senà, J. A., and Jorg, M. E. **Researches on experimental keratoplasty.** Arch. de Oft. de Buenos Aires, 1941, v. 16, Sept., p. 495.

The authors report their researches with keratoplasty on rabbit eyes, with a very detailed histopathologic study of corneal grafts. (Illustrations, photomicrographs.) Plinio Montalván.

Swan, K. C., and White, N. G. **Corneal permeability. 1. Factors affecting penetration of drugs into the cornea.** Amer. Jour. Ophth., 1942, v. 25, Sept., pp. 1043-1057. (10 tables, 6 figures. bibliography.)

7

UVEAL TRACT, SYMPATHETIC DISEASE AND AQUEOUS HUMOR

Bettman, J. W. **Detachment of the pigment border of the iris.** Arch. of Ophth., 1942, v. 28, July, pp. 57-60. Also Trans. Western Ophth. Soc., 1941, 8th mtg.

One eye of a 48-year-old patient presented two rope-like strands, consisting of a series of nodular bodies which were enlargements of the normal pigment margin of the iris. The length of the strands corresponded to the extent of defect in the pigment border of the iris margin. The upper strand was in apposition with the anterior lens capsule and rubbed against it with changes in pupil size, but there was no exfoliation of the anterior capsule of the lens. In other respects, the eye was normal. Two months previously the patient had fallen ten feet and suffered a skull fracture. The author discusses the role of trauma in production of this condition and concludes that the cause of the detachment in this case was a congenital defect, even though the trauma may have been the immediate precipitating factor. He discusses the role of the marginal sinus in the production of flocculi and cysts. J. Hewitt Judd.

Dynes, J. B. **Adie's syndrome, its recognition and importance.** Jour. Amer. Med. Assoc., 1942, v. 119, Aug. 29, p. 1495.

In a series of eight cases the symptoms most frequently met with were nervousness and emotional disorders with instability of the autonomic nervous system. Absent tendon reflexes and tonic pupils were the outstanding characteristics. The syndrome must be distinguished from syphilis of the central nervous system. Adie's syndrome is a benign disorder requiring no special therapy. (2 figures.)

George H. Stine.

Harbin, W., Jr., and Harbin, T. S. **Uveoparotitis.** Annals of Internal Med., 1942, v. 16, Feb., p. 360.

Two cases of this condition are reported, one typical and the other showing involvement of the submaxillary glands. The authors conclude that the condition is a true clinical entity. They do not believe that these cases are necessarily tuberculous, but suggest that the syndrome may arise from hypersensitivity to a number of allergens.

T. E. Sanders.

Keil, F. C., Jr., and Root, W. S. **The effect of the urethane of beta-methylcholine-chloride upon the parasympathectomized cat's eye.** Amer. Jour. Physiology, 1942, v. 136, March 1, p. 173.

In a series of nine cats the pupil was parasympathetically denervated by removal of the ciliary ganglion. The authors found that the denervated pupil contracted with a much smaller dose of intravenous beta-methylcholine than was needed for the normal pupil. They believe that this decrease in acetylcholine sensitivity is related to increased activity of the choline-esterase system. T. E. Sanders.

Kinsey, V. E., Grant, W. M., Cogan, D. G., Livingood, J. J., and Curtis, B. R. **Sodium, chloride, and phosphorus movement and the eye.** Arch. of Ophth., 1942, v. 27, June, pp. 1126-1131.

The artificially radioactive elements used in this study were separately prepared in the cyclotron. Their rate of accumulation in the normal anterior chamber of the rabbit was determined after introduction into the blood. It was found that sodium and chloride entered the anterior chamber from the blood stream at a rate sufficient to produce 50 percent of the concentration present in the plasma after approximately forty minutes. The rate of accumulation of radioactive phosphorus, probably in the form of phosphate, in the anterior chamber is much less rapid than that for sodium and chloride. It appears therefore that measurements of the formation of whole aqueous involving changes of volume indicate indirectly the electrolyte net-volume changes and show that water movement is only coincidental.

J. Hewitt Judd.

Kossina, E. G. **Sympathetic ophthalmia.** Publications Helmholtz Inst. of Ophth. (Russia), 1940, p. 203.

This material comprises 110 cases divided etiologically as follows: 87 cases following perforating injuries; 5 cases following perforating ulcers, and 18 following operations. Of the postoperative cases 14 developed after cataract extraction, one after an antiglaucomatous iridectomy, one after an optical iridectomy, and one after tattooing. Of seven postoperative cataract cases which developed sympathetic ophthalmia, two had a conjunctival-flap incision with iridectomy, two had extraction with a round pupil, and three were intracapsular. All seven had postoperative cyclitis; in five the history indicates inclusion of uveal tissue in the wound: four have notes on lens remains. The largest number of cases of sympathetic ophthalmia occurred in the young: 42 patients were under 15 years of age, and 18 were between 16 and 25 years. The interval between the injury and involvement of the fellow eye varied from one week to 25 years. Of the two cases which developed within one week after injury, one followed a gunshot wound and one perforation of the sclera by a cow's horn. Twenty-eight eyes were not enucleated; 15 preserved visual acuity of not less than 0.05. In one case the injured and the sympathizing eye were left with the same visual acuity. In most cases the sympathizing eye was more deeply involved and was lost in advance of the injured eye. In one case the injured eye had better vision than the sympathizing eye and in one case the sympathizing eye was so badly involved that it was enucleated. In 67 cases the injured eye was enucleated as a therapeutic procedure; in 38 the result was

satisfactory and in 29 poor. In 62 percent of the cases with satisfactory result the enucleation was done within a few days after the onset of sympathetic ophthalmia: on admission there were extensive corneal precipitates, broad synechiae, occlusion of the pupil, and a poor fundus reflex. In 13 cases sympathetic ophthalmia developed after enucleation of the injured eye.

Ray K. Daily.

8

GLAUCOMA AND OCULAR TENSION

Engel, Samuel. **Influence of a constricted pupil on the field in glaucoma.** Arch. of Ophth., 1942, v. 27, June, pp. 1184-1187.

Red fields taken on different occasions may show further constriction of an already narrowed field if taken when the pupil is small, and may thus erroneously give the impression of progressive glaucoma. Consideration of the size of the pupil will eliminate this error. The size of the pupil, in itself, as a mechanical obstacle, cannot cause the change, because the wider field for white stays the same. The explanation given is that the pin-point pupil decreases the amount of light which falls on the retina, and as the illumination diminishes the red becomes darker. The diminished illumination and especially the darkening of red require a higher degree of ocular functional capacity, and apparently the slope which borders the already impaired glaucomatous field, particularly on its nasal side, is so gentle and its level so low that the slightest change causes a recession of the borders, while the normal field, with its higher level and its steeper borders, is not affected. Field changes caused by contriction of the pupil were found in the case presented.

J. Hewitt Judd.

Evans, J. N. **Diagnostic aids in the study of glaucoma.** Arch. of Ophth., 1942, v. 27, June, pp. 1177-1183.

With the directions for its use the author describes a graphic record which has been found to be practical and useful for office, glaucoma clinic, and hospital ward. A schedule for provocative tests is described, and the value of tests other than provocative is pointed out, especially the fluorescein test for capillary permeability.

J. Hewitt Judd.

NEWS ITEMS

Edited by Dr. Ralph H. Miller
803 Carew Tower, Cincinnati

News items should reach the editor by the twelfth of the month.

Deaths

Dr. Donald M. Campbell, Detroit, Michigan, died August 25, 1942, aged 77 years.

Dr. Julius Henry Gross, Saint Louis, Missouri, died August 17, 1942, aged 70 years.

Dr. William Herbert Lowry, Toronto, Ontario, Canada, died July 13, 1942, aged 62 years.

Dr. Edwin W. Mackey, Tampa, Florida, died July 11, 1942, aged 72 years.

Dr. Carl C. McClelland, Detroit, Michigan, died July 29, 1942, aged 62 years.

Dr. Albert W. Greene, Schenectady, New York, died August 11, 1942, aged 54 years.

Dr. James H. Mills, Maysville, South Carolina, died July 17, 1942, aged 61 years.

Dr. Robert L. Cline, Lakeland, Florida, died July 7, 1942, aged 70 years.

Dr. John W. Fitzgerald, Beaumont, Texas, died July 13, 1942, aged 75 years.

Dr. Robert E. Gilbert, Winter Haven, Florida, died August 6, 1942, aged 51 years.

Dr. Joseph U. Vaillencourt, Quebec, Canada, died recently, aged 60 years.

Dr. Francis Downing, Norwich, Connecticut, died August 10, 1942, aged 60 years.

Miscellaneous

The following graduate instruction lectures have been given by the Department of Ophthalmology, Manhattan Eye, Ear, and Throat Hospital: "Corneal opacities" by Dr. R. Townley Paton; "Orbital infections" by Dr. Louis Hubert; "Developmental anomalies of the eye" by Dr. Plinio Montalván; "Contact glasses" by Mr. Theodore Obrig; "Ocular malingering in relation to the selective service act" by Dr. Guernsey Frey. The November schedule included "Trachoma" by Dr. G. Bonaccolto; "Endophthalmitis and panophthalmitis" by Dr. Joseph Laval; "Refraction" by Dr. Plinio Montalván; "Syphilis of the eye" by Dr. R. Townley Paton; "Refraction—The prescription of glasses in presbyopia" by Dr. Walter Hipp; and "Uveitis" by Dr. Joseph Laval.

Societies

At the clinical congress of the Connecticut State Medical Society, September 29th to October 1st, Dr. Phillips Thygeson spoke on "Chemotherapy in diseases of the eye."

The fifteenth annual graduate session of the New York Academy of Medicine was held October 12th to 23d. Among the participants in the evening lectures was Dr. Frank B. Walsh, Baltimore, who discussed "Certain abnormalities of ocular movements: Their importance in general and neurologic diagnosis."

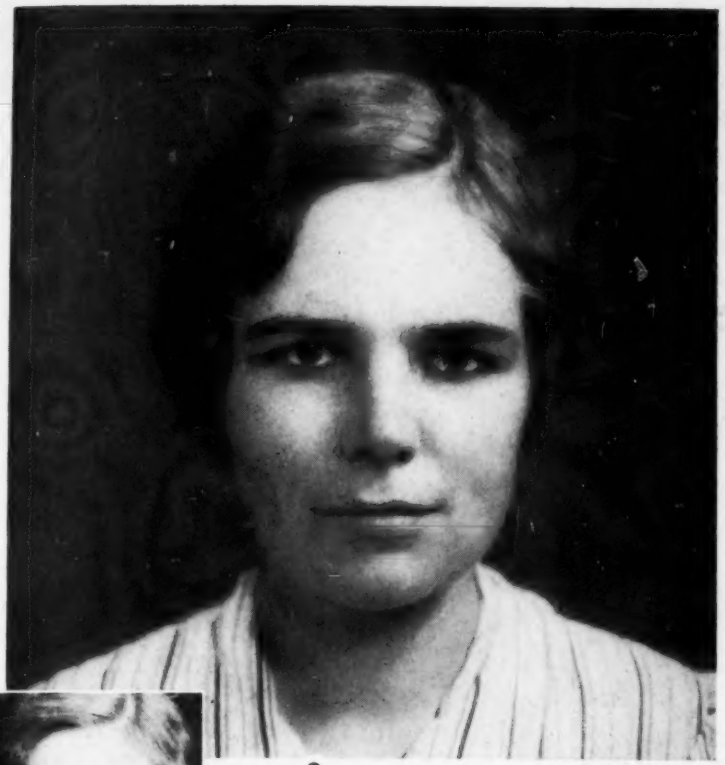
At the one-hundred-and-fifty-third annual session of the Medical Society of Delaware, held October 13th, Dr. William O. LaMotte lectured on "Primary glaucoma: Etiology, symptoms, diagnosis."

The Inter-State Postgraduate Medical Association of North America held its twenty-seventh-annual-international medical assembly from October 26th to 30th. Drs. Cecil S. O'Brien and William F. Moncreiff took part in the very extensive program. Dr. O'Brien addressed the assembly on "Glaucoma and the general practitioner," and Dr. Moncreiff on "Eye injuries in modern warfare."

Personals

From Dr. Vail has come the following message: "I arrived safely, smooth trip, and am well. Enjoying my work, which is interesting. It requires much traveling, and I have found my allied colleagues very coöperative.

"I am quartered fortunately in a single room. Although there is not heat in it, still it is comfortable. The food is good at the mess, and of good variety. Tobacco and cigarettes can be obtained at the post exchange. The people here are truly wonderful, cheerful and determined."



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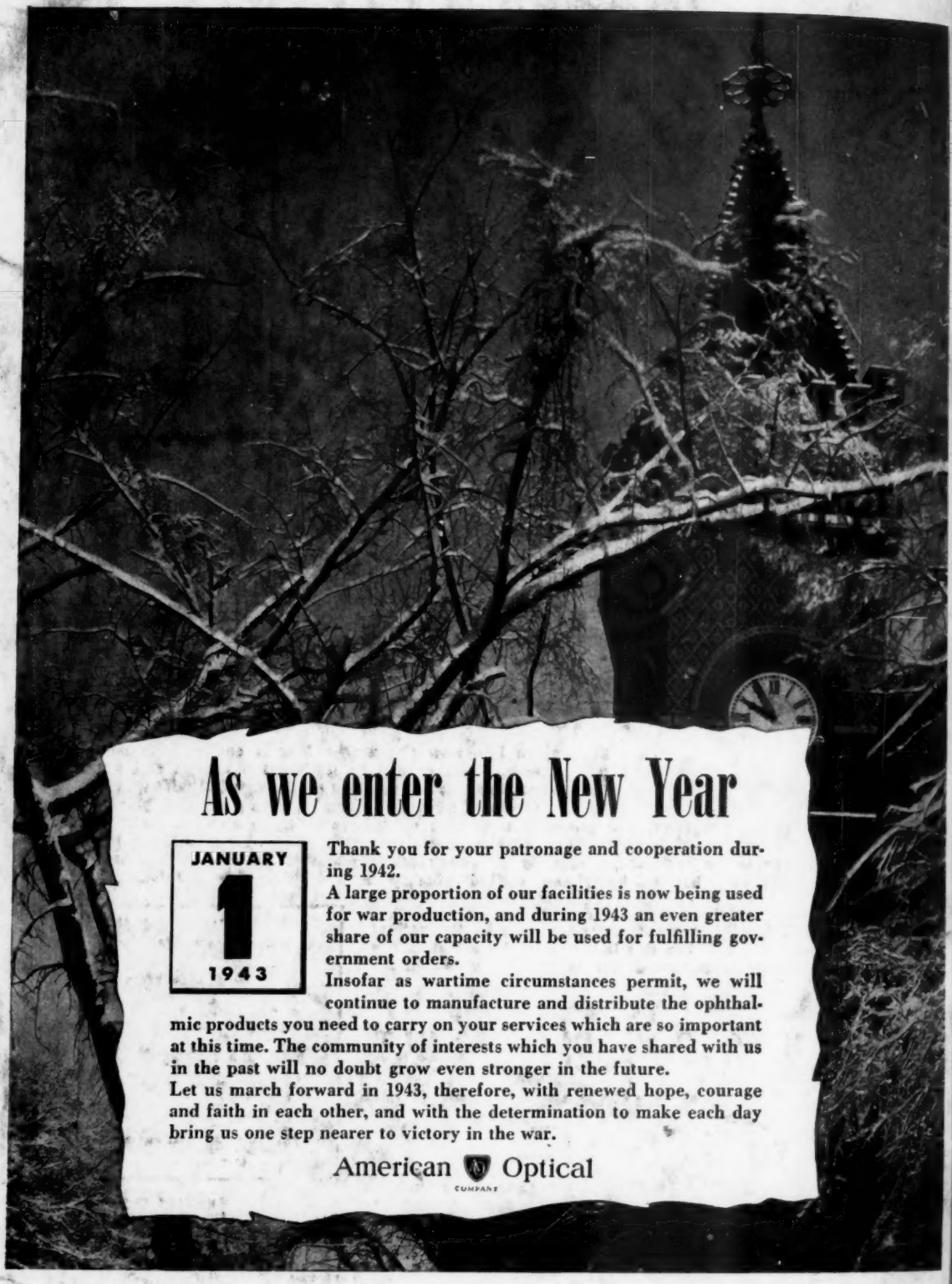
As we enter the New Year
JANUARY
1
1943
Thank you for your patronage and cooperation during 1942.
A large proportion of our facilities is now being used for war production, and during 1943 an even greater share of our capacity will be used for fulfilling government orders.
Insofar as wartime circumstances permit, we will continue to manufacture and distribute the ophthalmic products you need to carry on your services which are so important at this time. The community of interests which you have shared with us in the past will no doubt grow even stronger in the future.
Let us march forward in 1943, therefore, with renewed hope, courage and faith in each other, and with the determination to make each day bring us one step nearer to victory in the war.
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